Anatomy: Abdomen

Question 1 of 125



Posteriorly the spleen lies in the region of which of the following:

a Ribs 7 and 8

b Ribs 8 – 10

c Ribs 9 – 11

d Ribs 10 – 12

e Below the costal margin

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Anatomy: Abdomen

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Posteriorly the spleen lies in the region of which of the following:

a) Ribs 7 and 8
b) Ribs 8 – 10
c) **Ribs 9 – 11** ✔
d) Ribs 10 – 12
e) Below the costal margin

Answer

The spleen projects onto the left side and back in the area of ribs 9 – 11. The spleen follows the contour of rib 10 and extends from the superior pole of the left kidney to just posterior to the midaxillary line.

Notes

The intraperitoneal spleen lies against the diaphragm, in the area of rib 9 – 11. It lies in the left hypochondrium of the abdomen. The spleen cannot normally be palpated on clinical examination.

The spleen is an organ of the reticuloendothelial system and acts:

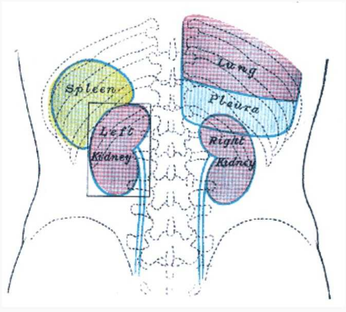
- to filter blood to remove old and defective blood cells
- as a blood reservoir
- to produce white blood cells
- to produce an immune response

Relations

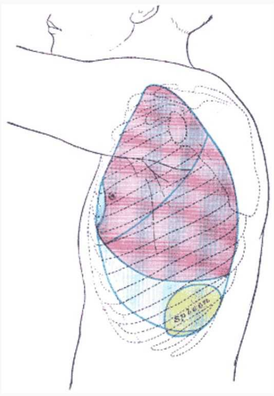
The spleen lies posterior to the stomach, superior to the left colic flexure and laterally to the left kidney and tail of the pancreas.

Surface markings

The spleen projects onto the left side and back in the area of ribs 9 – 11. The spleen follows the contour of rib 10 and extends from the superior pole of the left kidney to just posterior to the midaxillary line.



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Splenic rupture

This most commonly occurs due to localised trauma to the left upper quadrant. It may be associated with left lower rib fractures. Because the spleen has an extremely thin capsule it is susceptible to injury even when there is no damage to surrounding structures and because the spleen is highly vascular, when ruptured, it bleeds profusely into the peritoneal cavity.

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Anatomy: Abdomen



Question 2 of 125

The second part of the duodenum extends between which of the following vertebral levels:

a T12 – L1

b L1 – L3

c L1 – L2

d T12 – L2

e L2 – L3

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The second part of the duodenum extends between which of the following vertebral levels:

a) T12 – L1 ✗
b) L1 – L3 ✓
c) L1 – L2
d) T12 – L2
e) L2 – L3

Answer

The descending (second) part is just to the right of the midline, extending from the neck of the gallbladder, at vertebral level L3 to the lower border of vertebra L3 and lying lateral to the head of the pancreas. This part contains the major duodenal papilla which is the common entrance for the bile and pancreatic ducts.

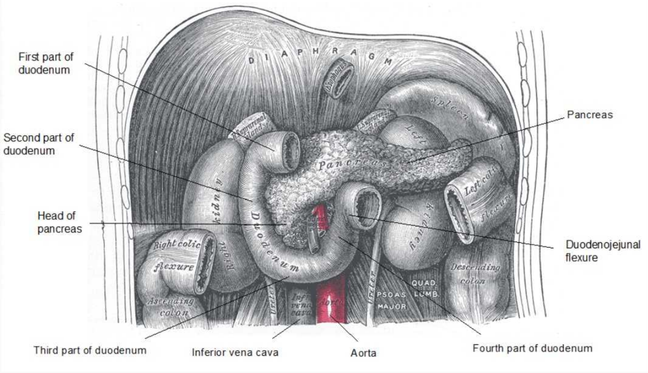
Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum. The first part of the small intestine is the duodenum.

The duodenum is a C-shaped structure, adjacent to the head of the pancreas, and above the level of the umbilicus. It is retroperitoneal except for its proximal part which is connected to the liver by the hepatoduodenal ligament of the lesser omentum.

Parts of the duodenum

- The superior (first) part extends from the pyloric orifice of the stomach to the neck of the gallbladder, lies just to the right of the body of vertebra L1, and passes anterior to the inferior vena cava and superior to the head of the pancreas.
- The descending (second) part is just to the right of the midline, extending from the neck of the gallbladder to the lower border of vertebra L3 and lying lateral to the head of the pancreas. This part contains the major duodenal papilla which is the common entrance for the bile and pancreatic ducts.
- The inferior (third) part is the longest section, crossing the inferior vena cava, the aorta and the vertebral column at the level of vertebra L3 and lying inferior to the pancreas.
- The ascending (fourth) part passes upwards on, or to the left of the aorta to approximately the upper border of vertebra L2 and terminates at the duodenojejunal flexure.



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Blood supply

The arterial supply of the duodenum is primarily from the pancreaticoduodenal arteries, branches of the superior mesenteric artery and the gastroduodenal artery (branch of the common hepatic artery from the coeliac trunk).

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Anatomy: Abdomen



Question 3 of 125

The infracolic compartment is divided into right and left spaces by which of the following structures:

a Jejunum

b Ileum

c Mesentery

d Transverse mesocolon

e Sigmoid mesocolon

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The infracolic compartment is divided into right and left spaces by which of the following structures:

a) Jejunum ✗
b) Ileum
c) Mesentery ✓
d) Transverse mesocolon
e) Sigmoid mesocolon

Answer

The infracolic compartment lies below the transverse mesocolon, is divided into left and right parts by the oblique attachment of the mesentery and contains the small intestine and the ascending and descending colon. The left infracolic compartment is continuous with the pelvic cavity.

Notes

Structure	Key anatomy
Peritoneal cavity	Divided into greater and lesser sacs
Greater sac	Divided into supracolic and infracolic compartments by transverse mesocolon, compartments connected by paracolic gutters
Supracolic compartment	Contains stomach, liver and spleen, lies under cover of costal limits of thoracic cage
Infracolic compartment	Divided into left and right parts by oblique attachment of mesentery, contains small intestine and ascending/descending colon, continuous with pelvic cavity
Lesser sac (omental bursa	Lies posterior to stomach and liver and anterior to pancreas, continuous with greater sac through epiploic foramen
Greater omentum	Descends from greater curvature of stomach and first part of duodenum, drapes inferiorly over transverse colon, jejunum and ileum, folds back up and ascends to adhere to transverse colon/mesocolon before arriving at posterior abdominal wall
Lesser omentum	Extends from lesser curvature of stomach and first part of duodenum to inferior surface of liver
Mesentery	Connects jejunum and ileus to posterior abdominal wall, attaches superiorly to duodenojejunal junction and passes oblique downwards and to the right to end at ileocecal junction
Transverse mesocolon	Connects transverse colon to posterior abdominal wall, leaves posterior abdominal wall across anterior surface of head and body of pancreas and passes outwards to surround transverse colon
Sigmoid mesocolon	Connects sigmoid colon to abdominal wall, V-shaped fold with apex near division of left common iliac artery, left limb descending along medial border of left psoas major muscle and right limb descending into pelvis to end at vertebral level S3

Compartments of the peritoneal cavity

The peritoneal cavity is divided into the greater sac and the omental bursa (lesser sac).

The greater sac accounts for most of the space in the peritoneal cavity, beginning superiorly at the diaphragm and continuing inferiorly in the pelvic cavity. It is further divided into two compartments by the transverse mesocolon:

- The supracolic compartment lies above the transverse mesocolon and contains the stomach, liver and spleen. It lies largely under cover of the costal limits of the thoracic cage.
- The infracolic compartment lies below the transverse mesocolon, is divided into left and right parts by the oblique attachment of the mesentery and contains the small intestine and the ascending and descending colon. The left infracolic compartment is continuous with the pelvic cavity.

The supracolic and infracolic compartments are connected by the paracolic gutters which lie between the posterolateral abdominal wall and the lateral aspect of the ascending or descending colon.

The omental bursa (lesser sac) is a smaller subdivision of the peritoneal cavity posterior to the stomach and liver and anterior to the pancreas, and is continuous with the greater sac through the epiploic foramen.

Omenta

The omenta are double layers of peritoneum that extends from the stomach and proximal part of the duodenum to other organs.

The greater omentum descends from the greater curvature of the stomach and first part of the duodenum, drapes inferiorly over the transverse colon and the coils of the jejunum and ileum, then folds back up posteriorly and ascends to become adherent to the peritoneum on the superior surface of the transverse colon and the anterior layer of the transverse mesocolon before arriving at the posterior abdominal wall.

The lesser omentum is considerably smaller and extends from the lesser curvature of the stomach and the first part of the duodenum to the inferior surface of the liver.

The greater omentum is often referred to as the 'policeman of the abdomen' because of its apparent ability to migrate to any inflamed area and wrap itself around the organ to wall off inflammation. The greater omentum is also an important site for metastatic tumour spread; direct omental spread by a transcoelomic route is common for carcinoma of the ovary.

Mesenteries

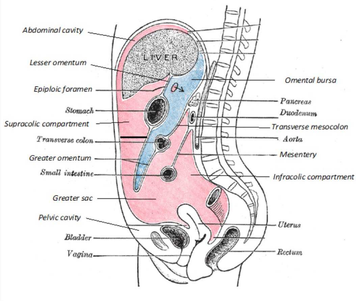
Mesenteries are peritoneal folds that attach viscera to the posterior abdominal wall. They allow some movement and provide a conduit for vessels, nerves and lymphatics to reach the viscera and include:

- the mesentery – associated with parts of the small intestine
- the transverse mesocolon – associated with transverse colon
- the sigmoid mesocolon – associated with the sigmoid colon.

The mesentery is a large, fan-shaped, double-layered fold of peritoneum that connects the jejunum and ileum to the posterior abdominal wall. Its superior attachment is at the duodenojejunal junction, just to the left of the upper lumbar part of the vertebral column. It passes obliquely downwards and to the right, ending at the ileocaecal junction near the upper border of the right sacroiliac joint.

The transverse mesocolon is a fold of peritoneum that connects the transverse colon to the posterior abdominal wall. It leaves the posterior abdominal wall across the anterior surface of the head and body of the pancreas and passes outwards to surround the transverse colon. Its anterior layer is adherent to the posterior layer of the greater omentum.

The sigmoid mesocolon is an inverted V-shaped peritoneal fold that attaches the sigmoid colon to the abdominal wall. The apex of the V is near the division of the left common iliac artery, with the left limb of the descending V along the medial border of the left psoas major muscle, and the right limb descending into the pelvis to end at the level of vertebra S3.



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Anatomy: Abdomen



Question 4 of 125

The aorta enters the abdomen at which of the following vertebral levels:

a T8

b T9

c T10

d T12

e L1

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Anatomy: Abdomen

Question 4 of 125

The aorta enters the abdomen at which of the following vertebral levels:

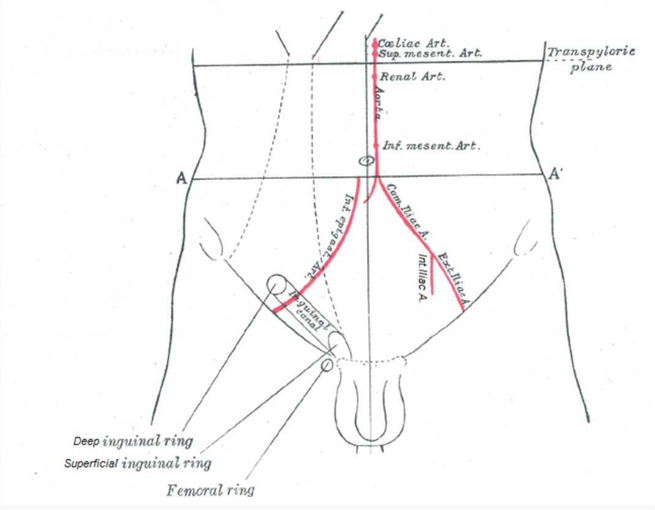
a) T8
b) T9
c) T10
d) T12 ✔
e) L1 ✖

Answer

The abdominal aorta begins at the aortic hiatus of the diaphragm, anterior to the lower border of vertebra T12.

Notes

The abdominal aorta begins at the aortic hiatus of the diaphragm, anterior to the lower border of vertebra T12. It descends through the abdomen, anterior to the vertebral bodies, and by the time it ends at the level of vertebra L4 it is slightly to the left of the midline. The main terminal branches of the abdominal aorta are the two common iliac arteries. This bifurcation can be visualised on the anterior abdominal wall as a point approximately 2.5 cm below the umbilicus.



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The abdominal aorta gives rise to:

- three anterior unpaired visceral branches
  - the coeliac trunk supplying the abdominal foregut (upper border of L1 vertebra)
  - the superior mesenteric artery supplying the abdominal midgut (lower border of L1 vertebra)
  - the inferior mesenteric artery supplying the abdominal hindgut (L3 vertebra)
- three lateral paired visceral branches
  - the middle suprarenal arteries
  - the renal arteries (L2 vertebra)
  - the gonadal arteries
- posterior parietal branches
  - the inferior phrenic arteries (paired)
  - the lumbar arteries (paired)
  - the median sacral artery (single)
- two terminal branches
  - left common iliac artery
  - right common iliac artery

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Anatomy: Abdomen



Question 5 of 125

A 64 year old man is brought to ED with profuse haematemesis. Endoscopy shows oesophageal varices which are most likely the result of anastomosis of the left gastric vein with which of the following vessels:

a Abdominal aorta

b Azygos system of veins

c Inferior mesenteric vein

d Superior mesenteric vein

e Portal vein

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Anatomy: Abdomen

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A 64 year old man is brought to ED with profuse haematemesis. Endoscopy shows oesophageal varices which are most likely the result of anastomosis of the left gastric vein with which of the following vessels:

a) **Abdominal aorta** ✗
b) Azygos system of veins ✓
c) Inferior mesenteric vein
d) Superior mesenteric vein
e) Portal vein

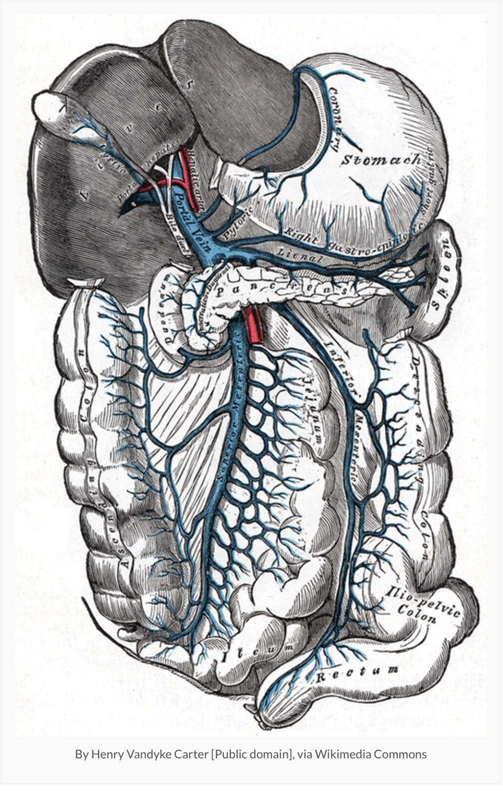
Answer

The left gastric vein and its tributaries form a portosystemic anastomosis with oesophageal tributaries to the azygos system of veins of the caval system at the gastroesophageal junction around the cardia of the stomach.

Notes

The portal vein is the final common pathway for the transport of venous blood from the spleen, pancreas, gallbladder and abdominal part of the gastrointestinal tract.

It is formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2.



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Portosystemic anastomoses

The hepatic portal system drains deoxygenated nutrient-rich blood from the visceral organs of the abdomen to the liver. Normally 100% of portal venous blood flow is recovered from the hepatic veins. In patients with elevated portal vein pressure e.g. from cirrhosis, there is significantly less blood flow to the liver and the rest of the blood enters collateral channels which drain into the systemic circulation at specific points.

Portosystemic anastomoses occur at certain specific points, the largest of these being:

- The gastroesophageal junction around the cardia of the stomach where the left gastric vein and its tributaries from a portosystemic anastomosis with tributaries to the azygos system of veins of the caval system
- The anus where the superior rectal vein of the portal system anastomoses with the middle and inferior rectal veins of the systemic venous system
- The anterior abdominal wall around the umbilicus where the portal paraumbilical veins anastomose with systemic veins on the anterior abdominal wall

When pressure in the portal vein is elevated, venous enlargement (varices) tends to occur at and around these sites producing:

- oesophageal varices at the gastroesophageal junction
- varices at the anorectal junction
- caput medusae at the umbilicus

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Anatomy: Abdomen



Question 6 of 125

The superficial inguinal ring is an 'opening' in which of the following structures:

a External oblique aponeurosis

b Internal oblique aponeurosis

c Transversus abdominis aponeurosis

d Rectus abdominis aponeurosis

e Transversalis fascia

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The superficial inguinal ring is an 'opening' in which of the following structures:

a) External oblique aponeurosis ✔
b) Internal oblique aponeurosis
c) Transversus abdominis aponeurosis
d) Rectus abdominis aponeurosis
e) Transversalis fascia

Answer

The superficial inguinal ring is a triangular opening in the aponeurosis of the external oblique, with its apex pointing superolaterally and its base formed by the pubic crest.

Notes

Space	Inguinal canal
Position	Between deep and superficial inguinal rings, just above and parallel to lower half of inguinal ligament
Anterior wall	Formed by external oblique aponeurosis (reinforced by internal oblique muscle laterally)
Posterior wall	Formed by transversalis fascia (reinforced by conjoint tendon medially)
Roof	Formed by transversus abdominis and internal oblique muscles
Floor	Formed by medial one-half of inguinal ligament (reinforced by lacunar ligament medially)
Deep inguinal ring	Opening in transversalis fascia, located just superior to mid-inguinal point (midway between ASIS and pubic symphysis)
Superficial inguinal ring	Opening in external oblique aponeurosis, located just superior to pubic tubercle
Contents	Genital branch of genitofemoral nerve, spermatic cord, round ligament, ilioinguinal nerve

Position

The inguinal canal is a slit-like passage that extends in a downwards and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the deep inguinal ring and continues for approximately 4 cm, ending at the superficial inguinal ring.

Roof, walls and floor

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle, and reinforced by the internal oblique muscle laterally.

The posterior wall of the inguinal canal is formed along its entire length by the transversalis fascia and reinforced by the conjoint tendon medially.

The roof of the inguinal canal is formed by arching fibres of the transversus abdominis and internal oblique muscles.

The floor of the inguinal canal is formed by the medial one-half of the inguinal ligament, reinforced medially by the lacunar ligament.

Deep inguinal ring

The deep inguinal ring, the opening in the transversalis fascia, is the beginning of the inguinal canal.

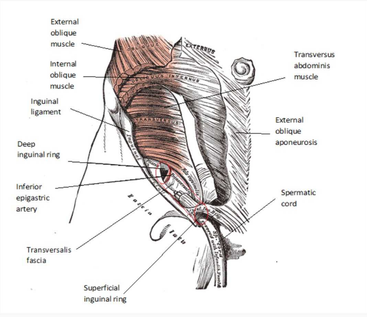
The deep inguinal ring is located just superior to a point midway between the anterior superior iliac spine and the pubic symphysis (the mid-inguinal point). N.B. Some sources state it is located at a slightly different site, just superior to a point midway between the anterior superior iliac spine and the pubic tubercle (the midpoint of the inguinal ligament).

It lies just above the inguinal ligament and immediately lateral to the inferior epigastric vessels; the femoral artery can be palpated in the same position but below the inguinal ligament.

Superficial inguinal ring

The superficial inguinal ring is the end of the inguinal canal.

The superficial inguinal ring is located just superior to the pubic tubercle. It is a triangular opening in the aponeurosis of the external oblique, with its apex pointing superolaterally and its base formed by the pubic crest.



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Contents

The inguinal canal contains:

- the genital branch of the genitofemoral nerve (within the spermatic cord in men)
- the spermatic cord in men
- the round ligament in women
- the ilioinguinal nerve (passes through part of the canal, exiting the superficial inguinal ring with the other contents)

Inguinal hernia

An inguinal hernia is the protrusion of a peritoneal sac through a weakened part of the abdominal wall in the groin.

Hernia	Indirect inguinal hernia	Direct inguinal hernia
Aetiology	Congenital – patent processus vaginalis	Acquired – weakened abdominal musculature
Mechanism	Peritoneal sac herniates through deep inguinal ring	Peritoneal sac herniates directly through posterior wall of inguinal canal
Relation to inferior epigastric vessels	Lateral to inferior epigastric vessels	Medial to inferior epigastric vessels

In indirect inguinal hernias, the most common type, the peritoneal sac enters the inguinal canal by passing through the deep inguinal ring, due to a patent embryonic processus vaginalis. If the entire processus vaginalis remains patent, the peritoneal sac may traverse the length of the canal, exit the superficial inguinal ring and continue into the scrotum or labia majora.

In direct inguinal hernias, the peritoneal sac passes directly through the posterior wall of the inguinal canal. It usually occurs when abdominal musculature has been weakened, in older men, following surgery or due to persistent raised intra-abdominal pressure. This type of hernia does not traverse the inguinal canal, but may still exit the superficial inguinal ring to enter the scrotum.

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Anatomy: Abdomen



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Visceral afferent fibres from the descending and sigmoid colon travel to which of the following spinal cord segments:

a T6 – T8

b T8 – T10

c T10 – T12

d L1 – L2

e L3 – L4

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Visceral afferent fibres from the descending and sigmoid colon travel to which of the following spinal cord segments:

a) T6 – T8 ✗
b) T8 – T10
c) T10 – T12
d) L1 – L2 ✓
e) L3 – L4

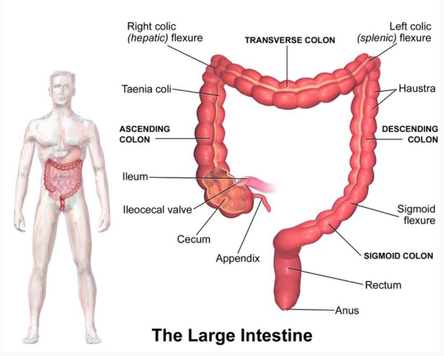
Answer

The visceral pain sensation from the ascending and transverse colon travels through the lesser splanchnic nerve to the T10 – T11 spinal cord segments hence pain is referred to the umbilical and hypogastric regions.

Pain from the descending and sigmoid colon is carried in the lumbar splanchnic nerves to the L1 and L2 spinal cord segments hence pain is referred to the inguinal region and thigh.

Notes

The large intestine extends from the distal end of the ileum to the anus, and comprises the caecum, appendix, colon, rectum and anal canal.



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Colon

The colon continues from the caecum in the right groin as the ascending colon, which passes upwards through the right flank and into the right hypochondrium.

Just below the right lobe of the liver, it bends to the left forming the right colic flexure (hepatic flexure), and crosses the abdomen as the transverse colon to the left hypochondrium. The transverse colon is related superiorly to the liver, gallbladder, greater curvature of the stomach and the lateral end of the spleen.

At this point, just below the spleen, it bends downwards forming the left colic flexure (splenic flexure) and continues as the descending colon through the left flank and into the left groin. The splenic flexure is higher and more posterior than the hepatic flexure, and is attached to the diaphragm by the phrenicocolic ligament.

The colon enters the upper part of the pelvis as the sigmoid colon, which begins above the pelvic inlet and extends to the level of vertebra S3 where it is continuous with the rectum. This S-shaped structure is quite mobile except at its proximal and distal end which are attached to the descending colon and rectum respectively. Between these points, it is suspended by the sigmoid mesocolon.

The ascending and descending segments are retroperitoneal and the transverse and sigmoid segments are intraperitoneal.

Relations

Colon	Anterior relations	Posterior relations
Ascending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, right kidney
Transverse colon	Liver, gallbladder, stomach, greater omentum, anterior abdominal wall	Second part of duodenum, head of pancreas, upper end of mesentery, duodenojejunal flexure, coils of jejunum and ileum
Descending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, left kidney
Sigmoid colon	Bladder, uterus and upper vagina	Rectum, sacrum, ileum

Blood supply

The arterial supply to the colon is derived from the superior mesenteric artery (caecum, appendix, ascending colon, hepatic flexure, proximal two-thirds of transverse colon) and the inferior mesenteric artery (distal one-thirds of transverse colon, splenic flexure, descending colon, sigmoid colon).

As the terminal vessels of the superior mesenteric and inferior mesenteric artery approach the colon they split into many colic branches which anastomose with each other. These anastomoses from a continuous arterial channel which extends the length of the colon, the marginal artery.

At the junctional area of the supply of the superior and inferior mesenteric arteries, the anastomosis may not be sufficient, thus the splenic flexure is most susceptible to ischaemia.

Innervation

The visceral pain sensation from the ascending and transverse colon travels through the lesser splanchnic nerve to the T10 – T11 spinal cord segments hence pain is referred to the umbilical and hypogastric regions.

Pain from the descending and sigmoid colon is carried in the lumbar splanchnic nerves to the L1 and L2 spinal cord segments hence pain is referred to the inguinal region and thigh.

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Anatomy: Abdomen



Question 8 of 125

A 65 year old man presents to ED complaining of abdominal pain, jaundice and weight loss. Imaging shows a tumour of the head of the pancreas. Which of the following structures is most likely compressed by this tumour:

a Common hepatic duct

b Left hepatic duct

c Cystic duct

d Accessory pancreatic duct

e Common bile duct

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Anatomy: Abdomen

Question 8 of 125

A 65 year old man presents to ED complaining of abdominal pain, jaundice and weight loss. Imaging shows a tumour of the head of the pancreas. Which of the following structures is most likely compressed by this tumour:

a) **Common hepatic duct** ✗
b) Left hepatic duct
c) Cystic duct
d) Accessory pancreatic duct
e) Common bile duct ✓

Answer

The lower region of the common bile duct lies in a groove on the posterior surface of the head of the pancreas to the left of the second part of the duodenum. An obstruction at this site causes a backup of bile back through the common bile duct and hepatic ducts with resultant pain and jaundice.

Notes

Biliary tree

The biliary tree begins in the liver parenchyma with the formation of the left and right hepatic duct which drain bile from the liver where it has been synthesised. These two ducts meet to form the common hepatic duct which runs near the liver, with the hepatic artery proper and portal vein in the free margin of the lesser omentum.

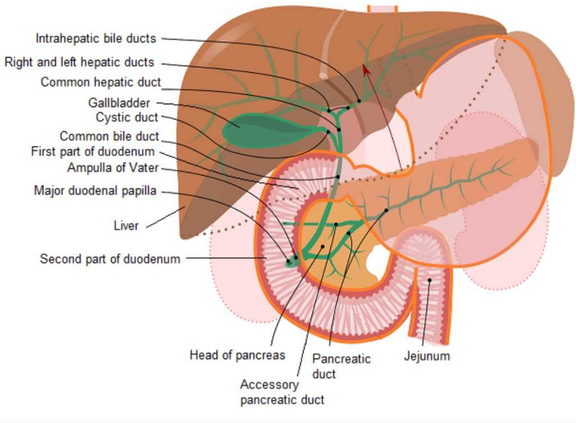
As the common hepatic duct descends, it is joined by the cystic duct, which is a continuation of the neck of the gallbladder. The common hepatic duct and the cystic duct combine to form the common bile duct. At this point the bile duct lies to the right of the hepatic artery proper and usually to the right of, and anterior to, the portal vein in the free margin of the lesser omentum.

As the common bile duct descends, it passes posterior to the first part of the duodenum before joining with the pancreatic duct from the pancreas, forming the hepatopancreatic ampulla (ampulla of Vater) at the major duodenal papilla, located in the second part of the duodenum. Surrounding the ampulla is the sphincter of Oddi, a collection of smooth muscle which can open to allow bile and pancreatic fluid to empty into the duodenum.

Common bile duct relations

The common bile duct can be divided into three main regions, based on its relation to the duodenum:

- The first supraduodenal region is the upper one-third which lies in the free margin of the lesser omentum with the hepatic artery and portal vein. The common bile duct lies anterior to the portal vein and to the right of the hepatic artery proper.
- The second retroduodenal region is the middle one-third which lies posterior to the first part of the duodenum. The gastroduodenal artery lies on its left aspect and the portal vein on its posterior aspect.
- The third infraduodenal region is the lower one-third which lies in a groove on the posterior surface of the head of the pancreas, to the left of the second part of the duodenum and anterior to the right renal vein and inferior vena cava.



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Anatomy: Abdomen



Question 9 of 125

Pain in the jejunum and ileum is typically referred to which of the following regions:

a Flank

b Epigastrium

c Left upper quadrant

d Right lower quadrant

e Umbilical region

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Anatomy: Abdomen

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Pain in the jejunum and ileum is typically referred to which of the following regions:

a) Flank ✗
b) Epigastrium
c) Left upper quadrant
d) Right lower quadrant
e) Umbilical region ✓

Answer

Pain from the small jejunum and ileum (midgut structures) is referred to the peri-umbilical region.

Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum.

The jejunum and ileum make up the last two sections of the small intestine.

The jejunum and ileum are intraperitoneal, attached to the posterior abdominal wall by the mesentery.

Jejunum

The jejunum represents the proximal two-fifths. It is mostly in the left upper quadrant of the abdomen and is larger in diameter and has a thicker wall than the ileum.

Ileum

The ileum makes up the distal three-fifths and is mostly in the right lower quadrant. The ileum invaginates into the large intestine at the ileocaecal junction forming the ileocaecal valve, which prevents reflux from the caecum to the ileum and regulates the passage of contents from the ileum to the caecum.

Blood supply

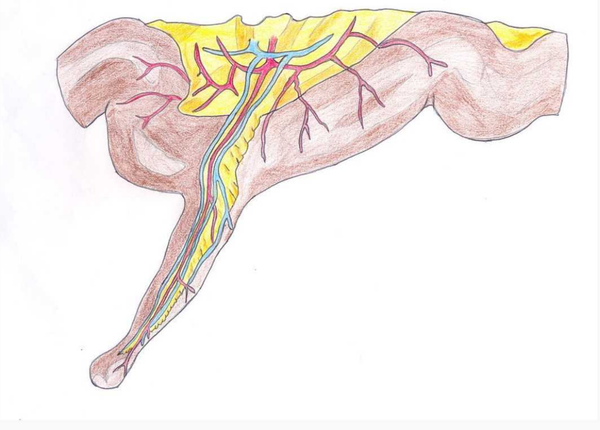
The arterial supply to the jejunum and ileum is derived from the superior mesenteric artery.

Innervation

The sympathetic nerve supply is derived from the T9 – T10 spinal cord segments. Pain from the small jejunum and ileum is referred to the peri-umbilical region.

Meckel's diverticulum

A Meckel's diverticulum is the remnant of the proximal part of the yolk stalk (vitelline duct) that extends into the umbilical cord in the embryo and lies on the antimesenteric border of the ileum, approximately **2 feet** proximal to the ileocaecal junction. It appears as a blind-ended tubular outpouching of bowel, about **2 inches** long, occurring in about **2%** of the population, and may contain **two types** of ectopic tissue (gastric and pancreatic). Complications include haemorrhage, intussusception, diverticulitis, ulceration and obstruction, and symptoms may mimic those of acute appendicitis.



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Anatomy: Abdomen



Question 10 of 125

Which of the following best describes the regions of the abdomen that the stomach occupies:

a Epigastric region

b Left hypochondrium

c Epigastric, umbilical and left hypochondriac regions

d Epigastric region and left hypochondrium

e Epigastric and right and left hypochondriac regions

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Which of the following best describes the regions of the abdomen that the stomach occupies:

a) **Epigastric region** ✖
b) Left hypochondrium
c) Epigastric, umbilical and left hypochondriac regions ✔
d) Epigastric region and left hypochondrium
e) Epigastric and right and left hypochondriac regions

Answer

The stomach is in the epigastric, umbilical and left hypochondriac regions of the abdomen.

Notes

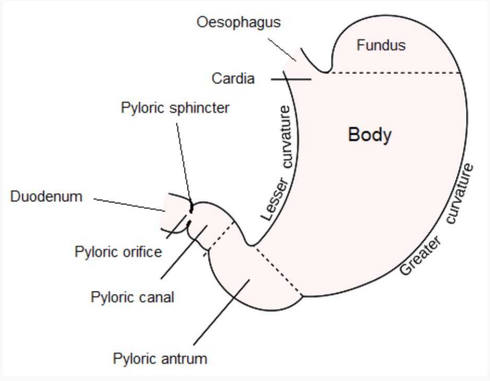
The stomach is the most dilated part of the gastrointestinal tract and has a J-like shape. The stomach is in the epigastric, umbilical and left hypochondriac regions of the abdomen. It is an intraperitoneal organ.

Anatomical distinctions

The stomach is divided into four regions:

- the cardia which surrounds the opening of the oesophagus into the stomach
- the fundus which is the area above the level of the cardiac orifice
- the body which is the largest central region of the stomach
- the pyloric part which is divided into the pyloric antrum and the pyloric canal which opens into the duodenum.

The most distal portion of the pyloric canal contains a thickened ring of gastric circular muscle, the pyloric sphincter that surrounds the distal pyloric orifice. The pyloric orifice is just to the right of the midline in the transpyloric plane. The pyloric sphincter controls the exit of chyme from the stomach into the duodenum. The sphincter is constricted by sympathetic stimulation and relaxed by parasympathetic action. Parasympathetic fibres in the vagus nerve are also secretomotor to gastric glands and motor to muscular wall of stomach.



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Relations

The stomach lies inferior to the diaphragm.

The stomach lies posterior to:

- the anterior abdominal wall
- the left costal margin
- the left lobe of the liver

The stomach lies anterior to the stomach bed formed by:

- the diaphragm
- the pancreas
- the transverse mesocolon
- the left colic flexure
- the left kidney
- the left adrenal gland
- the spleen

Blood supply

The arterial supply to the stomach is derived from all three branches (left gastric, splenic and common hepatic branches) of the coeliac trunk.

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The first part of the duodenum lies at the level of the body of which of the following vertebrae:

a T10

b T11

c T12

d L1

e L2

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The first part of the duodenum lies at the level of the body of which of the following vertebrae:

a) T10 ✗
b) T11
c) T12
d) L1 ✓
e) L2

Answer

The superior (first) part extends from the pyloric orifice of the stomach to the neck of the gallbladder, lies just to the right of the body of vertebra L1, and passes anterior to the inferior vena cava and superior to the head of the pancreas.

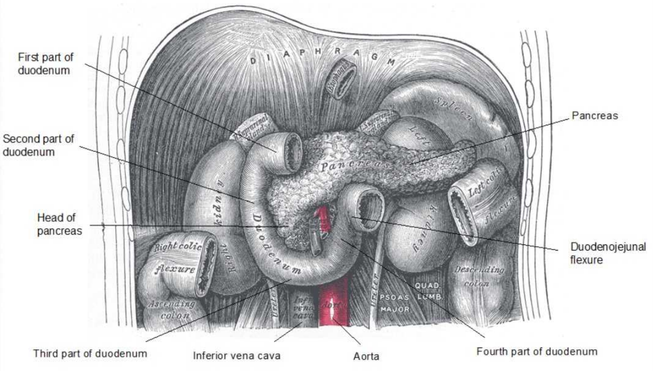
Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum. The first part of the small intestine is the duodenum.

The duodenum is a C-shaped structure, adjacent to the head of the pancreas, and above the level of the umbilicus. It is retroperitoneal except for its proximal part which is connected to the liver by the hepatoduodenal ligament of the lesser omentum.

Parts of the duodenum

- The superior (first) part extends from the pyloric orifice of the stomach to the neck of the gallbladder, lies just to the right of the body of vertebra L1, and passes anterior to the inferior vena cava and superior to the head of the pancreas.
- The descending (second) part is just to the right of the midline, extending from the neck of the gallbladder to the lower border of vertebra L3 and lying lateral to the head of the pancreas. This part contains the major duodenal papilla which is the common entrance for the bile and pancreatic ducts.
- The inferior (third) part is the longest section, crossing the inferior vena cava, the aorta and the vertebral column at the level of vertebra L3 and lying inferior to the pancreas.
- The ascending (fourth) part passes upwards on, or to the left of the aorta to approximately the upper border of vertebra L2 and terminates at the duodenojejunal flexure.



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Blood supply

The arterial supply of the duodenum is primarily from the pancreaticoduodenal arteries, branches of the superior mesenteric artery and the gastroduodenal artery (branch of the common hepatic artery from the coeliac trunk).

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Anatomy: Abdomen

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Which of the following describes the site of a Meckel's diverticulum:

a Duodenojejunal flexure

b Ileum

c Second part of duodenum

d Medial wall of caecum just inferior to ileocaecal valve

e Jejunum

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Which of the following describes the site of a Meckel's diverticulum:

a) Duodenojejunal flexure ✖
b) Ileum ✔
c) Second part of duodenum
d) Medial wall of caecum just inferior to ileocaecal valve
e) Jejunum

Answer

A Meckel's diverticulum is the remnant of the proximal part of the yolk stalk (vitelline duct) that extends into the umbilical cord in the embryo and lies on the antimesenteric border of the ileum, approximately 2 feet proximal to the ileocaecal junction. It appears as a blind-ended tubular outpouching of bowel, about 2 inches long, occurring in about 2% of the population, and may contain two types of ectopic tissue (gastric and pancreatic).

Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum.

The jejunum and ileum make up the last two sections of the small intestine.

The jejunum and ileum are intraperitoneal, attached to the posterior abdominal wall by the mesentery.

Jejunum

The jejunum represents the proximal two-fifths. It is mostly in the left upper quadrant of the abdomen and is larger in diameter and has a thicker wall than the ileum.

Ileum

The ileum makes up the distal three-fifths and is mostly in the right lower quadrant. The ileum invaginates into the large intestine at the ileocaecal junction forming the ileocaecal valve, which prevents reflux from the caecum to the ileum and regulates the passage of contents from the ileum to the caecum.

Blood supply

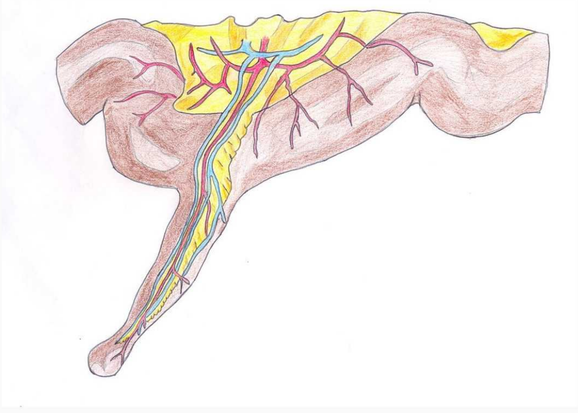
The arterial supply to the jejunum and ileum is derived from the superior mesenteric artery.

Innervation

The sympathetic nerve supply is derived from the T9 – T10 spinal cord segments. Pain from the small jejunum and ileum is referred to the peri-umbilical region.

Meckel's diverticulum

A Meckel's diverticulum is the remnant of the proximal part of the yolk stalk (vitelline duct) that extends into the umbilical cord in the embryo and lies on the antimesenteric border of the ileum, approximately **2 feet** proximal to the ileocaecal junction. It appears as a blind-ended tubular outpouching of bowel, about **2 inches** long, occurring in about **2%** of the population, and may contain **two types** of ectopic tissue (gastric and pancreatic). Complications include haemorrhage, intussusception, diverticulitis, ulceration and obstruction, and symptoms may mimic those of acute appendicitis.



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Anatomy: Abdomen



Question 13 of 125

A 29 year old man presents to ED with a painful lump in his left groin. Which of the following structures can be used as a landmark to differentiate between a direct and an indirect inguinal hernia:

a Inguinal ligament

b Femoral canal

c Inferior epigastric vessels

d Pubic symphysis

e Femoral artery

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A 29 year old man presents to ED with a painful lump in his left groin. Which of the following structures can be used as a landmark to differentiate between a direct and an indirect inguinal hernia:

a) **Inguinal ligament** ✘
b) Femoral canal
c) Inferior epigastric vessels ✔
d) Pubic symphysis
e) Femoral artery

Answer

A direct inguinal hernia (in contrast to an indirect inguinal hernia) does not pass through the deep inguinal ring but directly through the posterior wall of the inguinal canal, through the lower portion of the inguinal triangle which is bordered laterally by the inferior epigastric vessels. Therefore an indirect inguinal hernia is lateral to the inferior epigastric vessels, but a direct inguinal hernia is medial to these vessels.

Notes

Space	Inguinal canal
Position	Between deep and superficial inguinal rings, just above and parallel to lower half of inguinal ligament
Anterior wall	Formed by external oblique aponeurosis (reinforced by internal oblique muscle laterally)
Posterior wall	Formed by transversalis fascia (reinforced by conjoint tendon medially)
Roof	Formed by transversus abdominis and internal oblique muscles
Floor	Formed by medial one-half of inguinal ligament (reinforced by lacunar ligament medially)
Deep inguinal ring	Opening in transversalis fascia, located just superior to mid-inguinal point (midway between ASIS and pubic symphysis)
Superficial inguinal ring	Opening in external oblique aponeurosis, located just superior to pubic tubercle
Contents	Genital branch of genitofemoral nerve, spermatic cord, round ligament, ilioinguinal nerve

Position

The inguinal canal is a slit-like passage that extends in a downwards and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the deep inguinal ring and continues for approximately 4 cm, ending at the superficial inguinal ring.

Roof, walls and floor

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle, and reinforced by the internal oblique muscle laterally.

The posterior wall of the inguinal canal is formed along its entire length by the transversalis fascia and reinforced by the conjoint tendon medially.

The roof of the inguinal canal is formed by arching fibres of the transversus abdominis and internal oblique muscles.

The floor of the inguinal canal is formed by the medial one-half of the inguinal ligament, reinforced medially by the lacunar ligament.

Deep inguinal ring

The deep inguinal ring, the opening in the transversalis fascia, is the beginning of the inguinal canal.

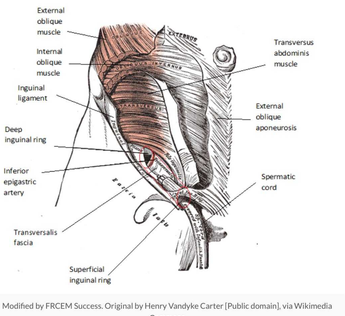
The deep inguinal ring is located just superior to a point midway between the anterior superior iliac spine and the pubic symphysis (the mid-inguinal point). N.B. Some sources state it is located at a slightly different site, just superior to a point midway between the anterior superior iliac spine and the pubic tubercle (the midpoint of the inguinal ligament).

It lies just above the inguinal ligament and immediately lateral to the inferior epigastric vessels; the femoral artery can be palpated in the same position but below the inguinal ligament.

Superficial inguinal ring

The superficial inguinal ring is the end of the inguinal canal.

The superficial inguinal ring is located just superior to the pubic tubercle. It is a triangular opening in the aponeurosis of the external oblique, with its apex pointing superolaterally and its base formed by the pubic crest.



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Contents

The inguinal canal contains:

- the genital branch of the genitofemoral nerve (within the spermatic cord in men)
- the spermatic cord in men
- the round ligament in women
- the ilioinguinal nerve (passes through part of the canal, exiting the superficial inguinal ring with the other contents)

Inguinal hernia

An inguinal hernia is the protrusion of a peritoneal sac through a weakened part of the abdominal wall in the groin.

Hernia	Indirect inguinal hernia	Direct inguinal hernia
Aetiology	Congenital – patent processus vaginalis	Acquired – weakened abdominal musculature
Mechanism	Peritoneal sac herniates through deep inguinal ring	Peritoneal sac herniates directly through posterior wall of inguinal canal
Relation to inferior epigastric vessels	Lateral to inferior epigastric vessels	Medial to inferior epigastric vessels

In indirect inguinal hernias, the most common type, the peritoneal sac enters the inguinal canal by passing through the deep inguinal ring, due to a patent embryonic processus vaginalis. If the entire processus vaginalis remains patent, the peritoneal sac may traverse the length of the canal, exit the superficial inguinal ring and continue into the scrotum or labia majora.

In direct inguinal hernias, the peritoneal sac passes directly through the posterior wall of the inguinal canal. It usually occurs when abdominal musculature has been weakened, in older men, following surgery or due to persistent raised intra-abdominal pressure. This type of hernia does not traverse the inguinal canal, but may still exit the superficial inguinal ring to enter the scrotum.

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Anatomy: Abdomen



Question 14 of 125

Which of the following best describes the regions of the abdomen that the liver normally occupies:

a Left hypochondrium and epigastric region

b Right hypochondrium and right flank

c Right hypochondrium and umbilical region

d Right hypochondrium, epigastric region and left hypochondrium

e Right hypochondrium, epigastric region and umbilicus

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Anatomy: Abdomen



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Which of the following best describes the regions of the abdomen that the liver normally occupies:

a) **Left hypochondrium and epigastric region** ✘
b) Right hypochondrium and right flank
c) Right hypochondrium and umbilical region
d) Right hypochondrium, epigastric region and left hypochondrium ✔
e) Right hypochondrium, epigastric region and umbilicus

Answer

The liver is the largest visceral organ in the body and is primarily located in the right hypochondrium and epigastric region, extending into the left hypochondrium.

Notes

The liver is the largest visceral organ in the body and is primarily located in the right hypochondrium and epigastric region, extending into the left hypochondrium.

Surface marking

Most of the liver is under the right dome of the diaphragm and deep to the lower thoracic wall. The inferior margin of the liver can be palpated descending below the right costal margin on deep inspiration.

The inferior margin is indicated by a line that joins points at the right tenth costal cartilage in the midaxillary line, the tip of the right ninth costal cartilage, the transpyloric plane in the midline, the tip of the left eighth costal cartilage and the left fifth rib in the midclavicular line.

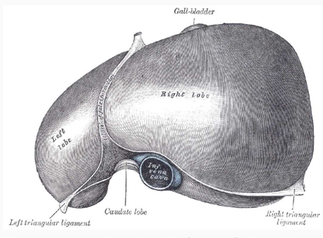
The superior margin is indicated by a line that joints a point on the left fifth rib at the midclavicular line to a corresponding point on the right side. The superior margin is concave in its central part and crosses behind the xiphisternal joint.

Anatomical surfaces

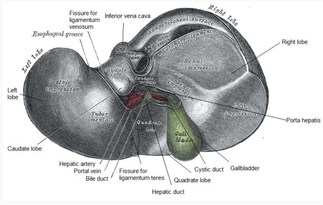
The liver has a diaphragmatic surface in the anterior, superior, and posterior directions and a visceral surface in the inferior direction.

The diaphragmatic surface of the liver is related anteriorly to the anterior abdominal wall and rib cage and superiorly to the diaphragm.

The visceral surface of the liver is related to the oesophagus, right anterior part of the stomach, superior part of the duodenum, lesser omentum, gallbladder, right colic flexure, right transverse colon, right kidney and right adrenal gland.



Diaphragmatic surface of liver. By Henry Vandyke Carter [Public domain], via Wikimedia Commons



Inferior surface of liver. Modified by FRCEM Success. Original by Henry Vandyke Carter [Public domain], via Wikimedia Commons

Lobes

There are four anatomical lobes to the liver.

- The liver is divided into the left and right lobe by the fossae for the gallbladder and the inferior vena cava.
- The caudate lobe sits between the fissure for the ligamentum venosum and the inferior vena cava.
- The quadrate lobe is located between the gallbladder and the fissure for the ligamentum teres.

The porta hepatis is the central intraperitoneal fissure of the liver that separates the caudate and the quadrate lobes. The porta hepatis serves as the point of entry into the liver for the hepatic arteries and portal vein, and the exit point for the hepatic ducts.

Liver lobules

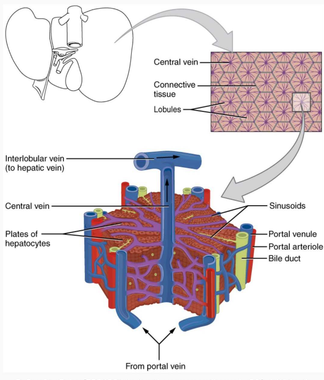
Microscopically, hepatocytes are arranged into lobules which are the functional units of the liver. Each lobule is hexagonal-shaped, and is drained by a venule in its centre, called a central vein (which drains to the hepatic vein).

At the periphery of the hexagon are three structures collectively known as the portal triad, comprising:

- a portal arteriole (a branch of the hepatic artery),
- a portal venule (a branch of the hepatic portal vein),
- a bile duct.

The portal triad also contains lymphatic vessels and vagal parasympathetic nerve fibres.

The liver sinusoids serve as a location for mixing of the oxygen-rich blood from the hepatic artery and the nutrient-rich blood from the portal vein.



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Blood supply

The liver has a unique dual blood supply. The arterial supply to the liver is from the left and right hepatic arteries derived from the hepatic artery proper, a branch of the common hepatic artery from the coeliac trunk.

The hepatic portal vein (formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2) supplies the liver with deoxygenated blood carrying nutrients absorbed from the small intestine.

Venous drainage of the liver is achieved through three hepatic veins, which return the venous blood to the inferior vena cava just inferior to the diaphragm.

Lymphatic drainage

The lymphatic vessels of the liver drain into hepatic lymph nodes which empty in the coeliac lymph nodes.

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Anatomy: Abdomen



Question 15 of 125

A 21 year old man presents to ED complaining of groin pain. Examination reveals an indirect inguinal hernia. Which of the following nerves is most likely compressed by the herniating structure in the inguinal canal to cause pain:

a Iliofemoral nerve

b Lateral femoral cutaneous nerve

c Ilioinguinal nerve

d Subcostal nerve

e Inferior epigastric nerve

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Anatomy: Abdomen

Question 15 of 125

A 21 year old man presents to ED complaining of groin pain. Examination reveals an indirect inguinal hernia. Which of the following nerves is most likely compressed by the herniating structure in the inguinal canal to cause pain:

a) **Iliofemoral nerve** ✗
b) Lateral femoral cutaneous nerve
c) Ilioinguinal nerve ✓
d) Subcostal nerve
e) Inferior epigastric nerve

Answer

The ilioinguinal nerve runs with the spermatic cord in the inguinal canal to innervate the anterior portion of the scrotum and proximal parts of the genitals, and could become compressed in an indirect inguinal hernia.

Notes

Space	Inguinal canal
Position	Between deep and superficial inguinal rings, just above and parallel to lower half of inguinal ligament
Anterior wall	Formed by external oblique aponeurosis (reinforced by internal oblique muscle laterally)
Posterior wall	Formed by transversalis fascia (reinforced by conjoint tendon medially)
Roof	Formed by transversus abdominis and internal oblique muscles
Floor	Formed by medial one-half of inguinal ligament (reinforced by lacunar ligament medially)
Deep inguinal ring	Opening in transversalis fascia, located just superior to mid-inguinal point (midway between ASIS and pubic symphysis)
Superficial inguinal ring	Opening in external oblique aponeurosis, located just superior to pubic tubercle
Contents	Genital branch of genitofemoral nerve, spermatic cord, round ligament, ilioinguinal nerve

Position

The inguinal canal is a slit-like passage that extends in a downwards and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the deep inguinal ring and continues for approximately 4 cm, ending at the superficial inguinal ring.

Roof, walls and floor

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle, and reinforced by the internal oblique muscle laterally.

The posterior wall of the inguinal canal is formed along its entire length by the transversalis fascia and reinforced by the conjoint tendon medially.

The roof of the inguinal canal is formed by arching fibres of the transversus abdominis and internal oblique muscles.

The floor of the inguinal canal is formed by the medial one-half of the inguinal ligament, reinforced medially by the lacunar ligament.

Deep inguinal ring

The deep inguinal ring, the opening in the transversalis fascia, is the beginning of the inguinal canal.

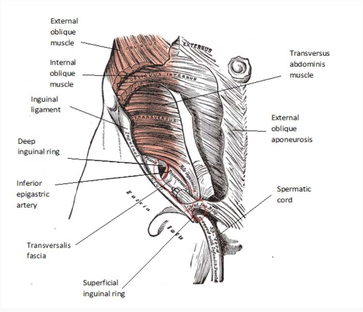
The deep inguinal ring is located just superior to a point midway between the anterior superior iliac spine and the pubic symphysis (the mid-inguinal point). N.B. Some sources state it is located at a slightly different site, just superior to a point midway between the anterior superior iliac spine and the pubic tubercle (the midpoint of the inguinal ligament).

It lies just above the inguinal ligament and immediately lateral to the inferior epigastric vessels; the femoral artery can be palpated in the same position but below the inguinal ligament.

Superficial inguinal ring

The superficial inguinal ring is the end of the inguinal canal.

The superficial inguinal ring is located just superior to the pubic tubercle. It is a triangular opening in the aponeurosis of the external oblique, with its apex pointing superolaterally and its base formed by the pubic crest.



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Contents

The inguinal canal contains:

- the genital branch of the genitofemoral nerve (within the spermatic cord in men)
- the spermatic cord in men
- the round ligament in women
- the ilioinguinal nerve (passes through part of the canal, exiting the superficial inguinal ring with the other contents)

Inguinal hernia

An inguinal hernia is the protrusion of a peritoneal sac through a weakened part of the abdominal wall in the groin.

Hernia	Indirect inguinal hernia	Direct inguinal hernia
Aetiology	Congenital – patent processus vaginalis	Acquired – weakened abdominal musculature
Mechanism	Peritoneal sac herniates through deep inguinal ring	Peritoneal sac herniates directly through posterior wall of inguinal canal
Relation to inferior epigastric vessels	Lateral to inferior epigastric vessels	Medial to inferior epigastric vessels

In indirect inguinal hernias, the most common type, the peritoneal sac enters the inguinal canal by passing through the deep inguinal ring, due to a patent embryonic processus vaginalis. If the entire processus vaginalis remains patent, the peritoneal sac may traverse the length of the canal, exit the superficial inguinal ring and continue into the scrotum or labia majora.

In direct inguinal hernias, the peritoneal sac passes directly through the posterior wall of the inguinal canal. It usually occurs when abdominal musculature has been weakened, in older men, following surgery or due to persistent raised intra-abdominal pressure. This type of hernia does not traverse the inguinal canal, but may still exit the superficial inguinal ring to enter the scrotum.

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Anatomy: Abdomen



Question 16 of 125

A direct inguinal hernia is due to weakness in which of the following layers:

a External oblique aponeurosis

b Transversalis fascia

c Transversus abdominis muscle

d Internal oblique aponeurosis

e External oblique muscle

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Anatomy: Abdomen

Question 16 of 125

A direct inguinal hernia is due to weakness in which of the following layers:

a) **External oblique aponeurosis** ✗
b) Transversalis fascia ✓
c) Transversus abdominis muscle
d) Internal oblique aponeurosis
e) External oblique muscle

Answer

A direct inguinal hernia is due to weakness in the posterior wall of the inguinal canal which is formed by the transversalis fascia.

Notes

Space	Inguinal canal
Position	Between deep and superficial inguinal rings, just above and parallel to lower half of inguinal ligament
Anterior wall	Formed by external oblique aponeurosis (reinforced by internal oblique muscle laterally)
Posterior wall	Formed by transversalis fascia (reinforced by conjoint tendon medially)
Roof	Formed by transversus abdominis and internal oblique muscles
Floor	Formed by medial one-half of inguinal ligament (reinforced by lacunar ligament medially)
Deep inguinal ring	Opening in transversalis fascia, located just superior to mid-inguinal point (midway between ASIS and pubic symphysis)
Superficial inguinal ring	Opening in external oblique aponeurosis, located just superior to pubic tubercle
Contents	Genital branch of genitofemoral nerve, spermatic cord, round ligament, ilioinguinal nerve

Position

The inguinal canal is a slit-like passage that extends in a downwards and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the deep inguinal ring and continues for approximately 4 cm, ending at the superficial inguinal ring.

Roof, walls and floor

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle, and reinforced by the internal oblique muscle laterally.

The posterior wall of the inguinal canal is formed along its entire length by the transversalis fascia and reinforced by the conjoint tendon medially.

The roof of the inguinal canal is formed by arching fibres of the transversus abdominis and internal oblique muscles.

The floor of the inguinal canal is formed by the medial one-half of the inguinal ligament, reinforced medially by the lacunar ligament.

Deep inguinal ring

The deep inguinal ring, the opening in the transversalis fascia, is the beginning of the inguinal canal.

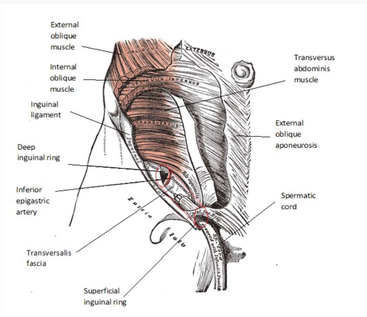
The deep inguinal ring is located just superior to a point midway between the anterior superior iliac spine and the pubic symphysis (the mid-inguinal point). N.B. Some sources state it is located at a slightly different site, just superior to a point midway between the anterior superior iliac spine and the pubic tubercle (the midpoint of the inguinal ligament).

It lies just above the inguinal ligament and immediately lateral to the inferior epigastric vessels; the femoral artery can be palpated in the same position but below the inguinal ligament.

Superficial inguinal ring

The superficial inguinal ring is the end of the inguinal canal.

The superficial inguinal ring is located just superior to the pubic tubercle. It is a triangular opening in the aponeurosis of the external oblique, with its apex pointing superolaterally and its base formed by the pubic crest.



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Contents

The inguinal canal contains:

- the genital branch of the genitofemoral nerve (within the spermatic cord in men)
- the spermatic cord in men
- the round ligament in women
- the ilioinguinal nerve (passes through part of the canal, exiting the superficial inguinal ring with the other contents)

Inguinal hernia

An inguinal hernia is the protrusion of a peritoneal sac through a weakened part of the abdominal wall in the groin.

Hernia	Indirect inguinal hernia	Direct inguinal hernia
Aetiology	Congenital – patent processus vaginalis	Acquired – weakened abdominal musculature
Mechanism	Peritoneal sac herniates through deep inguinal ring	Peritoneal sac herniates directly through posterior wall of inguinal canal
Relation to inferior epigastric vessels	Lateral to inferior epigastric vessels	Medial to inferior epigastric vessels

In indirect inguinal hernias, the most common type, the peritoneal sac enters the inguinal canal by passing through the deep inguinal ring, due to a patent embryonic processus vaginalis. If the entire processus vaginalis remains patent, the peritoneal sac may traverse the length of the canal, exit the superficial inguinal ring and continue into the scrotum or labia majora.

In direct inguinal hernias, the peritoneal sac passes directly through the posterior wall of the inguinal canal. It usually occurs when abdominal musculature has been weakened, in older men, following surgery or due to persistent raised intra-abdominal pressure. This type of hernia does not traverse the inguinal canal, but may still exit the superficial inguinal ring to enter the scrotum.

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Anatomy: Abdomen



Question 17 of 125

The posterior wall of the inguinal canal is formed primarily by which of the following structures:

a Transversus abdominis muscle

b External oblique aponeurosis

c Transversalis fascia

d External oblique muscle

e Internal oblique muscle

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Anatomy: Abdomen

Question 17 of 125

The posterior wall of the inguinal canal is formed primarily by which of the following structures:

a) **Transversus abdominis muscle** ✗
b) External oblique aponeurosis
c) Transversalis fascia ✓
d) External oblique muscle
e) Internal oblique muscle

Answer

The posterior wall of the inguinal canal is formed along its entire length by the transversalis fascia and reinforced by the conjoint tendon medially.

Notes

Space	Inguinal canal
Position	Between deep and superficial inguinal rings, just above and parallel to lower half of inguinal ligament
Anterior wall	Formed by external oblique aponeurosis (reinforced by internal oblique muscle laterally)
Posterior wall	Formed by transversalis fascia (reinforced by conjoint tendon medially)
Roof	Formed by transversus abdominis and internal oblique muscles
Floor	Formed by medial one-half of inguinal ligament (reinforced by lacunar ligament medially)
Deep inguinal ring	Opening in transversalis fascia, located just superior to mid-inguinal point (midway between ASIS and pubic symphysis)
Superficial inguinal ring	Opening in external oblique aponeurosis, located just superior to pubic tubercle
Contents	Genital branch of genitofemoral nerve, spermatic cord, round ligament, ilioinguinal nerve

Position

The inguinal canal is a slit-like passage that extends in a downwards and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the deep inguinal ring and continues for approximately 4 cm, ending at the superficial inguinal ring.

Roof, walls and floor

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle, and reinforced by the internal oblique muscle laterally.

The posterior wall of the inguinal canal is formed along its entire length by the transversalis fascia and reinforced by the conjoint tendon medially.

The roof of the inguinal canal is formed by arching fibres of the transversus abdominis and internal oblique muscles.

The floor of the inguinal canal is formed by the medial one-half of the inguinal ligament, reinforced medially by the lacunar ligament.

Deep inguinal ring

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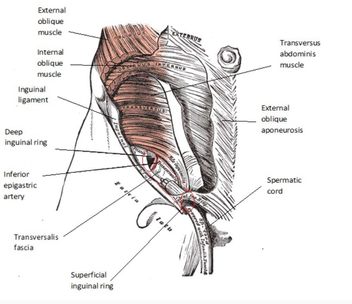
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It lies just above the inguinal ligament and immediately lateral to the inferior epigastric vessels; the femoral artery can be palpated in the same position but below the inguinal ligament.

Superficial inguinal ring

The superficial inguinal ring is the end of the inguinal canal.

The superficial inguinal ring is located just superior to the pubic tubercle. It is a triangular opening in the aponeurosis of the external oblique, with its apex pointing superolaterally and its base formed by the pubic crest.



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Contents

The inguinal canal contains:

- the genital branch of the genitofemoral nerve (within the spermatic cord in men)
- the spermatic cord in men
- the round ligament in women
- the ilioinguinal nerve (passes through part of the canal, exiting the superficial inguinal ring with the other contents)

Inguinal hernia

An inguinal hernia is the protrusion of a peritoneal sac through a weakened part of the abdominal wall in the groin.

Hernia	Indirect inguinal hernia	Direct inguinal hernia
Aetiology	Congenital – patent processus vaginalis	Acquired – weakened abdominal musculature
Mechanism	Peritoneal sac herniates through deep inguinal ring	Peritoneal sac herniates directly through posterior wall of inguinal canal
Relation to inferior epigastric vessels	Lateral to inferior epigastric vessels	Medial to inferior epigastric vessels

In indirect inguinal hernias, the most common type, the peritoneal sac enters the inguinal canal by passing through the deep inguinal ring, due to a patent embryonic processus vaginalis. If the entire processus vaginalis remains patent, the peritoneal sac may traverse the length of the canal, exit the superficial inguinal ring and continue into the scrotum or labia majora.

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Anatomy: Abdomen



Question 18 of 125

The inguinal ligament spans between which of the following two structures:

a Anterior superior iliac spine and pubic tubercle

b Anterior superior iliac spine and pubic symphysis

c Iliac crest and pubic symphysis

d Iliac crest and pubic tubercle

e Anterior superior iliac spine and pubic crest

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Anatomy: Abdomen

Question 18 of 125

The inguinal ligament spans between which of the following two structures:

a) Anterior superior iliac spine and pubic tubercle ✔
b) Anterior superior iliac spine and pubic symphysis
c) Iliac crest and pubic symphysis
d) Iliac crest and pubic tubercle
e) Anterior superior iliac spine and pubic crest

Answer

The lower free border of the external oblique aponeurosis forms the inguinal ligament on each side. The inguinal ligament runs between the anterior superior iliac spine laterally and the pubic tubercle medially.

Notes

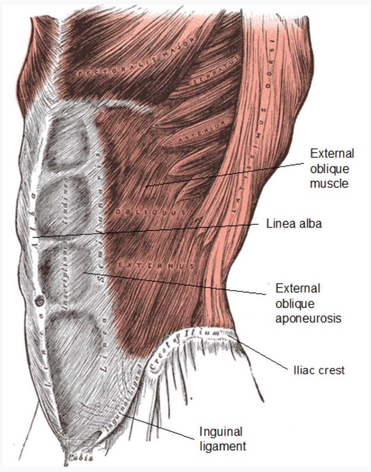
There are five muscles in the anterolateral group of abdominal wall muscles; three flat muscles whose fibres begin posterolaterally and pass anteriorly before being replaced by an aponeurosis as the muscle continues towards the midline (external oblique, internal oblique, transversus abdominis) and two vertical muscles enclosed by the tendinous sheath formed by the aponeuroses of the flat muscles (rectus abdominis, pyramidalis).

External oblique

The external oblique is the largest and most superficial of the anterior abdominal muscles, lying just deep to the superficial fascia. The external oblique originates from the outer surfaces of the lower eight ribs, its fibres running in an inferomedial direction before inserting onto the lateral lip of the iliac crest.

The external oblique has a large aponeurotic component that covers the anterior part of the abdominal wall and forms the linea alba at the midline, together with the aponeuroses from the internal oblique and the transversus abdominis. The linea alba extends from the xiphoid process to the pubic symphysis.

The lower free border of the external oblique aponeurosis forms the inguinal ligament on each side (which runs between the anterior superior iliac spine laterally and the pubic tubercle medially).



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Internal oblique

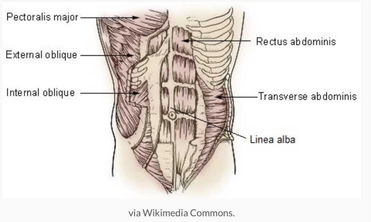
The internal oblique muscle lies deep to the external oblique. Its fibres run in a superomedial direction, originating from the thoracolumbar fascia, the iliac crest and the lateral two-thirds of the inguinal ligament and inserting onto the inferior border of the lower 3 – 4 ribs, the linea alba, the pubic crest and pectineal line.

Transversus abdominis

The transversus abdominis is the innermost of the flat anterior abdominal muscles, lying deep to the internal oblique. It originates from the thoracolumbar fascia, the iliac crest, the lateral one-third of the inguinal ligament and the 7th – 12th costal cartilages and inserts onto the linea alba, the pubic crest and the pectineal line.

Rectus abdominis

The rectus abdominis is a long muscle that extends the length of the anterior abdominal wall. It originates from the pubic crest, pubic tubercle and pubic symphysis and inserts onto the costal cartilages of ribs 5 – 7 and to the xiphoid process. It is a paired muscle, separated in the midline by the linea alba.



via Wikimedia Commons.

Function

The abdominal wall muscles form a firm, but flexible wall that keeps the abdominal viscera within the abdominal cavity, protects the viscera from injury and helps maintain the position of the viscera in the erect posture against the action of gravity.

The muscles act together to flex and rotate the vertebral column.

In addition, contraction of these muscles assists in forced expiration, and in coughing and vomiting, by pushing the viscera upwards. All of these muscles are involved in any action that increases intra-abdominal pressure, including childbirth, micturition and defaecation.

Innervation

The anterior abdominal wall muscles are innervated by the anterior rami of T7 – T12 and L1.

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Anatomy: Abdomen



Question 19 of 125

The anterior wall of the inguinal canal is formed primarily by which of the following structures:

a External oblique aponeurosis

b Transversalis fascia

c Internal oblique muscle

d External oblique muscle

e Rectus abdominis muscle

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Anatomy: Abdomen

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The anterior wall of the inguinal canal is formed primarily by which of the following structures:

a) External oblique aponeurosis ✔
b) Transversalis fascia
c) Internal oblique muscle
d) External oblique muscle
e) Rectus abdominis muscle

Answer

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle, and reinforced by the internal oblique muscle laterally.

Notes

Space	Inguinal canal
Position	Between deep and superficial inguinal rings, just above and parallel to lower half of inguinal ligament
Anterior wall	Formed by external oblique aponeurosis (reinforced by internal oblique muscle laterally)
Posterior wall	Formed by transversalis fascia (reinforced by conjoint tendon medially)
Roof	Formed by transversus abdominis and internal oblique muscles
Floor	Formed by medial one-half of inguinal ligament (reinforced by lacunar ligament medially)
Deep inguinal ring	Opening in transversalis fascia, located just superior to mid-inguinal point (midway between ASIS and pubic symphysis)
Superficial inguinal ring	Opening in external oblique aponeurosis, located just superior to pubic tubercle
Contents	Genital branch of genitofemoral nerve, spermatic cord, round ligament, ilioinguinal nerve

Position

The inguinal canal is a slit-like passage that extends in a downwards and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the deep inguinal ring and continues for approximately 4 cm, ending at the superficial inguinal ring.

Roof, walls and floor

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle, and reinforced by the internal oblique muscle laterally.

The posterior wall of the inguinal canal is formed along its entire length by the transversalis fascia and reinforced by the conjoint tendon medially.

The roof of the inguinal canal is formed by arching fibres of the transversus abdominis and internal oblique muscles.

The floor of the inguinal canal is formed by the medial one-half of the inguinal ligament, reinforced medially by the lacunar ligament.

Deep inguinal ring

The deep inguinal ring, the opening in the transversalis fascia, is the beginning of the inguinal canal.

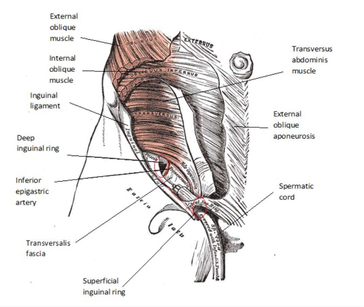
The deep inguinal ring is located just superior to a point midway between the anterior superior iliac spine and the pubic symphysis (the mid-inguinal point). N.B. Some sources state it is located at a slightly different site, just superior to a point midway between the anterior superior iliac spine and the pubic tubercle (the midpoint of the inguinal ligament).

It lies just above the inguinal ligament and immediately lateral to the inferior epigastric vessels; the femoral artery can be palpated in the same position but below the inguinal ligament.

Superficial inguinal ring

The superficial inguinal ring is the end of the inguinal canal.

The superficial inguinal ring is located just superior to the pubic tubercle. It is a triangular opening in the aponeurosis of the external oblique, with its apex pointing superolaterally and its base formed by the pubic crest.



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Contents

The inguinal canal contains:

- the genital branch of the genitofemoral nerve (within the spermatic cord in men)
- the spermatic cord in men
- the round ligament in women
- the ilioinguinal nerve (passes through part of the canal, exiting the superficial inguinal ring with the other contents)

Inguinal hernia

An inguinal hernia is the protrusion of a peritoneal sac through a weakened part of the abdominal wall in the groin.

Hernia	Indirect inguinal hernia	Direct inguinal hernia
Aetiology	Congenital – patent processus vaginalis	Acquired – weakened abdominal musculature
Mechanism	Peritoneal sac herniates through deep inguinal ring	Peritoneal sac herniates directly through posterior wall of inguinal canal
Relation to inferior epigastric vessels	Lateral to inferior epigastric vessels	Medial to inferior epigastric vessels

In indirect inguinal hernias, the most common type, the peritoneal sac enters the inguinal canal by passing through the deep inguinal ring, due to a patent embryonic processus vaginalis. If the entire processus vaginalis remains patent, the peritoneal sac may traverse the length of the canal, exit the superficial inguinal ring and continue into the scrotum or labia majora.

In direct inguinal hernias, the peritoneal sac passes directly through the posterior wall of the inguinal canal. It usually occurs when abdominal musculature has been weakened, in older men, following surgery or due to persistent raised intra-abdominal pressure. This type of hernia does not traverse the inguinal canal, but may still exit the superficial inguinal ring to enter the scrotum.

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Anatomy: Abdomen



Question 20 of 125

Which of the following nerves transmits the parasympathetic supply to the stomach:

a Greater thoracic splanchnic nerves

b Lesser thoracic splanchnic nerves

c Lumbar splanchnic nerves

d Pelvic splanchnic nerves

e Vagus nerves

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Anatomy: Abdomen

Question 20 of 125

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a) **Greater thoracic splanchnic nerves** ✖
b) Lesser thoracic splanchnic nerves
c) Lumbar splanchnic nerves
d) Pelvic splanchnic nerves
e) Vagus nerves ✔

Answer

The parasympathetic supply to the stomach is carried by the vagus nerve.

Notes

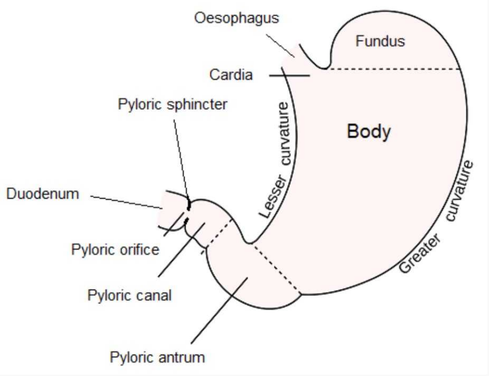
The stomach is the most dilated part of the gastrointestinal tract and has a J-like shape. The stomach is in the epigastric, umbilical and left hypochondriac regions of the abdomen. It is an intraperitoneal organ.

Anatomical distinctions

The stomach is divided into four regions:

- the cardia which surrounds the opening of the oesophagus into the stomach
- the fundus which is the area above the level of the cardiac orifice
- the body which is the largest central region of the stomach
- the pyloric part which is divided into the pyloric antrum and the pyloric canal which opens into the duodenum.

The most distal portion of the pyloric canal contains a thickened ring of gastric circular muscle, the pyloric sphincter that surrounds the distal pyloric orifice. The pyloric orifice is just to the right of the midline in the transpyloric plane. The pyloric sphincter controls the exit of chyme from the stomach into the duodenum. The sphincter is constricted by sympathetic stimulation and relaxed by parasympathetic action. Parasympathetic fibres in the vagus nerve are also secretomotor to gastric glands and motor to muscular wall of stomach.



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Relations

The stomach lies inferior to the diaphragm.

The stomach lies posterior to:

- the anterior abdominal wall
- the left costal margin
- the left lobe of the liver

The stomach lies anterior to the stomach bed formed by:

- the diaphragm
- the pancreas
- the transverse mesocolon
- the left colic flexure
- the left kidney
- the left adrenal gland
- the spleen

Blood supply

The arterial supply to the stomach is derived from all three branches (left gastric, splenic and common hepatic branches) of the coeliac trunk.

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Anatomy: Abdomen



Question 21 of 125

A 55 year old woman presents to ED complaining of abdominal pain and profuse vomiting. Imaging shows part of the bowel is being compressed between the abdominal aorta and the superior mesenteric artery. Which part of the bowel is most likely being affected:

a First part of the duodenum

b Second part of the duodenum

c Third part of the duodenum

d Ileum

e Jejunum

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Anatomy: Abdomen

Question 21 of 125

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a) **First part of the duodenum** ✗
b) Second part of the duodenum
c) Third part of the duodenum ✓
d) Ileum
e) Jejunum

Answer

The third part of the duodenum lies anterior to the abdominal aorta but posterior to the superior mesenteric artery and constriction between these structures can occur readily.

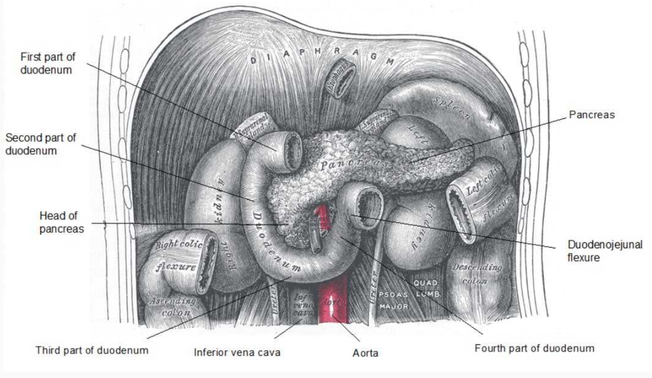
Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum. The first part of the small intestine is the duodenum.

The duodenum is a C-shaped structure, adjacent to the head of the pancreas, and above the level of the umbilicus. It is retroperitoneal except for its proximal part which is connected to the liver by the hepatoduodenal ligament of the lesser omentum.

Parts of the duodenum

- The superior (first) part extends from the pyloric orifice of the stomach to the neck of the gallbladder, lies just to the right of the body of vertebra L1, and passes anterior to the inferior vena cava and superior to the head of the pancreas.
- The descending (second) part is just to the right of the midline, extending from the neck of the gallbladder to the lower border of vertebra L3 and lying lateral to the head of the pancreas. This part contains the major duodenal papilla which is the common entrance for the bile and pancreatic ducts.
- The inferior (third) part is the longest section, crossing the inferior vena cava, the aorta and the vertebral column at the level of vertebra L3 and lying inferior to the pancreas.
- The ascending (fourth) part passes upwards on, or to the left of the aorta to approximately the upper border of vertebra L2 and terminates at the duodenojejunal flexure.



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Blood supply

The arterial supply of the duodenum is primarily from the pancreaticoduodenal arteries, branches of the superior mesenteric artery and the gastroduodenal artery (branch of the common hepatic artery from the coeliac trunk).

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Anatomy: Abdomen



Question 22 of 125

The liver is divided into the left and right lobes by which of the following structures:

a Fossae for the gallbladder and inferior vena cava

b Porta hepatis

c Portal vein

d Falciform ligament

e Ligamentum teres hepatis

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Anatomy: Abdomen

Question 22 of 125

The liver is divided into the left and right lobes by which of the following structures:

a) Fossae for the gallbladder and inferior vena cava ✔
b) Porta hepatis
c) Portal vein
d) Falciform ligament
e) Ligamentum teres hepatis

Answer

The liver is divided into the left and right lobe by the fossae for the gallbladder and the inferior vena cava.

Notes

The liver is the largest visceral organ in the body and is primarily located in the right hypochondrium and epigastric region, extending into the left hypochondrium.

Surface marking

Most of the liver is under the right dome of the diaphragm and deep to the lower thoracic wall. The inferior margin of the liver can be palpated descending below the right costal margin on deep inspiration.

The inferior margin is indicated by a line that joins points at the right tenth costal cartilage in the midaxillary line, the tip of the right ninth costal cartilage, the transpyloric plane in the midline, the tip of the left eighth costal cartilage and the left fifth rib in the midclavicular line.

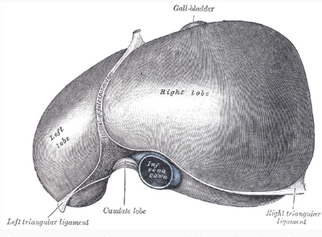
The superior margin is indicated by a line that joints a point on the left fifth rib at the midclavicular line to a corresponding point on the right side. The superior margin is concave in its central part and crosses behind the xiphisternal joint.

Anatomical surfaces

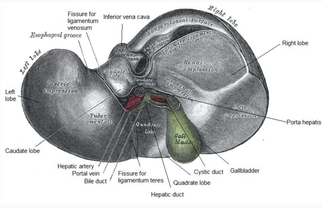
The liver has a diaphragmatic surface in the anterior, superior, and posterior directions and a visceral surface in the inferior direction.

The diaphragmatic surface of the liver is related anteriorly to the anterior abdominal wall and rib cage and superiorly to the diaphragm.

The visceral surface of the liver is related to the oesophagus, right anterior part of the stomach, superior part of the duodenum, lesser omentum, gallbladder, right colic flexure, right transverse colon, right kidney and right adrenal gland.



Diaphragmatic surface of liver. By Henry Vandyke Carter [Public domain], via Wikimedia Commons



Inferior surface of liver. Modified by FRCEM Success. Original by Henry Vandyke Carter [Public domain], via Wikimedia Commons

Lobes

There are four anatomical lobes to the liver.

- The liver is divided into the left and right lobe by the fossae for the gallbladder and the inferior vena cava.
- The caudate lobe sits between the fissure for the ligamentum venosum and the inferior vena cava.
- The quadrate lobe is located between the gallbladder and the fissure for the ligamentum teres.

The porta hepatis is the central intraperitoneal fissure of the liver that separates the caudate and the quadrate lobes. The porta hepatis serves as the point of entry into the liver for the hepatic arteries and portal vein, and the exit point for the hepatic ducts.

Liver lobules

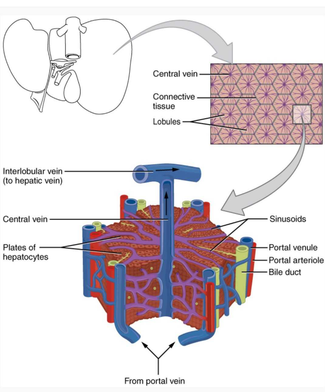
Microscopically, hepatocytes are arranged into lobules which are the functional units of the liver. Each lobule is hexagonal-shaped, and is drained by a venule in its centre, called a central vein (which drains to the hepatic vein).

At the periphery of the hexagon are three structures collectively known as the portal triad, comprising:

- a portal arteriole (a branch of the hepatic artery),
- a portal venule (a branch of the hepatic portal vein),
- a bile duct.

The portal triad also contains lymphatic vessels and vagal parasympathetic nerve fibres.

The liver sinusoids serve as a location for mixing of the oxygen-rich blood from the hepatic artery and the nutrient-rich blood from the portal vein.



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Blood supply

The liver has a unique dual blood supply. The arterial supply to the liver is from the left and right hepatic arteries derived from the hepatic artery proper, a branch of the common hepatic artery from the coeliac trunk.

The hepatic portal vein (formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2) supplies the liver with deoxygenated blood carrying nutrients absorbed from the small intestine.

Venous drainage of the liver is achieved through three hepatic veins, which return the venous blood to the inferior vena cava just inferior to the diaphragm.

Lymphatic drainage

The lymphatic vessels of the liver drain into hepatic lymph nodes which empty in the coeliac lymph nodes.

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Anatomy: Abdomen



Question 23 of 125

Which of the following is NOT an anterior relation of the transverse colon:

a Stomach

b Right lobe of liver

c Fundus of gallbladder

d Greater omentum

e Lesser omentum

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Anatomy: Abdomen

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Which of the following is NOT an anterior relation of the transverse colon:

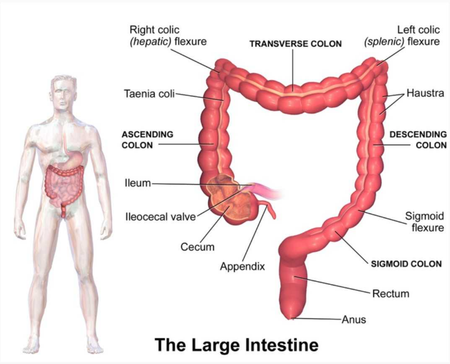
a) Stomach ✖
b) Right lobe of liver
c) Fundus of gallbladder
d) Greater omentum
e) Lesser omentum ✔

Answer

The transverse colon is related anteriorly to the anterior abdominal wall, greater omentum, stomach, liver and gallbladder. The lesser omentum is the double layer of peritoneum that extends from the liver to the lesser curvature of the stomach (hepatogastric ligament) and the first part of the duodenum (hepatoduodenal ligament).

Notes

The large intestine extends from the distal end of the ileum to the anus, and comprises the caecum, appendix, colon, rectum and anal canal.



Blausen.com staff. "Blausen gallery 2014". Wikiversity Journal of Medicine. DOI:10.15347/wjm/2014.010. ISSN 20018762. (Own work) [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons

Colon

The colon continues from the caecum in the right groin as the ascending colon, which passes upwards through the right flank and into the right hypochondrium.

Just below the right lobe of the liver, it bends to the left forming the right colic flexure (hepatic flexure), and crosses the abdomen as the transverse colon to the left hypochondrium. The transverse colon is related superiorly to the liver, gallbladder, greater curvature of the stomach and the lateral end of the spleen.

At this point, just below the spleen, it bends downwards forming the left colic flexure (splenic flexure) and continues as the descending colon through the left flank and into the left groin. The splenic flexure is higher and more posterior than the hepatic flexure, and is attached to the diaphragm by the phrenicocolic ligament.

The colon enters the upper part of the pelvis as the sigmoid colon, which begins above the pelvic inlet and extends to the level of vertebra S3 where it is continuous with the rectum. This S-shaped structure is quite mobile except at its proximal and distal end which are attached to the descending colon and rectum respectively. Between these points, it is suspended by the sigmoid mesocolon.

The ascending and descending segments are retroperitoneal and the transverse and sigmoid segments are intraperitoneal.

Relations

Colon	Anterior relations	Posterior relations
Ascending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, right kidney
Transverse colon	Liver, gallbladder, stomach, greater omentum, anterior abdominal wall	Second part of duodenum, head of pancreas, upper end of mesentery, duodenojejunal flexure, coils of jejunum and ileum
Descending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, left kidney
Sigmoid colon	Bladder, uterus and upper vagina	Rectum, sacrum, ileum

Blood supply

The arterial supply to the colon is derived from the superior mesenteric artery (caecum, appendix, ascending colon, hepatic flexure, proximal two-thirds of transverse colon) and the inferior mesenteric artery (distal one-thirds of transverse colon, splenic flexure, descending colon, sigmoid colon).

As the terminal vessels of the superior mesenteric and inferior mesenteric artery approach the colon they split into many colic branches which anastomose with each other. These anastomoses from a continuous arterial channel which extends the length of the colon, the marginal artery.

At the junctional area of the supply of the superior and inferior mesenteric arteries, the anastomosis may not be sufficient, thus the splenic flexure is most susceptible to ischaemia.

Innervation

The visceral pain sensation from the ascending and transverse colon travels through the lesser splanchnic nerve to the T10 – T11 spinal cord segments hence pain is referred to the umbilical and hypogastric regions.

Pain from the descending and sigmoid colon is carried in the lumbar splanchnic nerves to the L1 and L2 spinal cord segments hence pain is referred to the inguinal region and thigh.

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Anatomy: Abdomen



Question 24 of 125

Regarding the rectus abdominis muscle, which of the following statements is INCORRECT:

a It originates from the pubic crest, pubic tubercle and pubic symphysis.

b It inserts onto the costal cartilages of ribs 5 – 7 and to the xiphoid process.

c It is separated in the midline by the linea alba.

d The free lower border of its aponeurosis forms the inguinal ligament.

e It is intersected along it length by tendinous intersections.

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Anatomy: Abdomen



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Regarding the internal oblique muscle, which of the following statements is CORRECT:

a The lower free border of the internal oblique aponeurosis forms the inguinal ligament.

b The internal oblique lies deep to the transversus abdominis muscle.

c Its fibres run in a inferomedial direction.

d It originates from the medial third of the inguinal ligament.

e It inserts onto the lower 3 – 4 ribs and the pubic crest.

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Anatomy: Abdomen

Question 25 of 125

Regarding the internal oblique muscle, which of the following statements is CORRECT:

a)
The lower free border of the internal oblique aponeurosis forms the inguinal ligament.
b) The internal oblique lies deep to the transversus abdominis muscle.
c) Its fibres run in a inferomedial direction.
d) It originates from the medial third of the inguinal ligament.
e) It inserts onto the lower 3 – 4 ribs and the pubic crest.

Answer

The internal oblique muscle lies deep to the external oblique and superficial to the transversus abdominis. Its fibres run in a superomedial direction, originating from the thoracolumbar fascia, the iliac crest and the lateral two-thirds of the inguinal ligament and inserting onto the inferior border of the lower 3 – 4 ribs, the linea alba, the pubic crest and pectineal line.

Notes

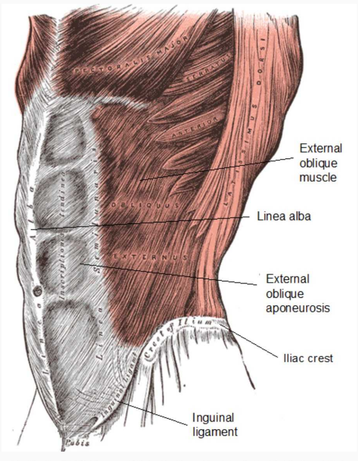
There are five muscles in the anterolateral group of abdominal wall muscles; three flat muscles whose fibres begin posterolaterally and pass anteriorly before being replaced by an aponeurosis as the muscle continues towards the midline (external oblique, internal oblique, transversus abdominis) and two vertical muscles enclosed by the tendinous sheath formed by the aponeuroses of the flat muscles (rectus abdominis, pyramidalis).

External oblique

The external oblique is the largest and most superficial of the anterior abdominal muscles, lying just deep to the superficial fascia. The external oblique originates from the outer surfaces of the lower eight ribs, its fibres running in an inferomedial direction before inserting onto the lateral lip of the iliac crest.

The external oblique has a large aponeurotic component that covers the anterior part of the abdominal wall and forms the linea alba at the midline, together with the aponeuroses from the internal oblique and the transversus abdominis. The linea alba extends from the xiphoid process to the pubic symphysis.

The lower free border of the external oblique aponeurosis forms the inguinal ligament on each side (which runs between the anterior superior iliac spine laterally and the pubic tubercle medially).



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Internal oblique

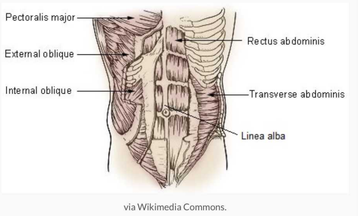
The internal oblique muscle lies deep to the external oblique. Its fibres run in a superomedial direction, originating from the thoracolumbar fascia, the iliac crest and the lateral two-thirds of the inguinal ligament and inserting onto the inferior border of the lower 3 – 4 ribs, the linea alba, the pubic crest and pectineal line.

Transversus abdominis

The transversus abdominis is the innermost of the flat anterior abdominal muscles, lying deep to the internal oblique. It originates from the thoracolumbar fascia, the iliac crest, the lateral one-third of the inguinal ligament and the 7th – 12th costal cartilages and inserts onto the linea alba, the pubic crest and the pectineal line.

Rectus abdominis

The rectus abdominis is a long muscle that extends the length of the anterior abdominal wall. It originates from the pubic crest, pubic tubercle and pubic symphysis and inserts onto the costal cartilages of ribs 5 – 7 and to the xiphoid process. It is a paired muscle, separated in the midline by the linea alba.



via Wikimedia Commons.

Function

The abdominal wall muscles form a firm, but flexible wall that keeps the abdominal viscera within the abdominal cavity, protects the viscera from injury and helps maintain the position of the viscera in the erect posture against the action of gravity.

The muscles act together to flex and rotate the vertebral column.

In addition, contraction of these muscles assists in forced expiration, and in coughing and vomiting, by pushing the viscera upwards. All of these muscles are involved in any action that increases intra-abdominal pressure, including childbirth, micturition and defaecation.

Innervation

The anterior abdominal wall muscles are innervated by the anterior rami of T7 – T12 and L1.

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Anatomy: Abdomen



Question 26 of 125

A 36 year old male is brought into ED complaining of fever, abdominal pain and tenderness. Imaging shows that an abdominal infection has spread retroperitoneally. Which of the following structures is most likely affected:

a Jejunum

b Head of the pancreas

c Transverse colon

d First part of duodenum

e Appendix

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Anatomy: Abdomen

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A 36 year old male is brought into ED complaining of fever, abdominal pain and tenderness. Imaging shows that an abdominal infection has spread retroperitoneally. Which of the following structures is most likely affected:

a) Jejunum ✗
b) Head of the pancreas ✓
c) Transverse colon
d) First part of duodenum
e) Appendix

Answer

The pancreas (except for a small part of the tail) is retroperitoneal. All the other structures are intraperitoneal.

Notes

The peritoneum is a continuous double-layered serous membrane.

The parietal peritoneum lines the walls of the abdominal cavity and the visceral peritoneum lines the viscera.

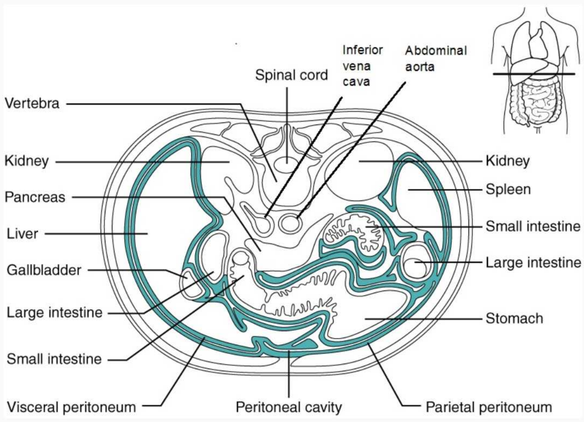
Between the parietal and visceral layers of peritoneum is a potential space, the peritoneal cavity.

Abdominal viscera are either suspended in the peritoneal cavity by folds of peritoneum called mesenteries (intraperitoneal viscera) or are outside the peritoneal cavity bound to the posterior abdominal wall (retroperitoneal viscera). Retroperitoneal organs are only covered in peritoneum on their anterior surface.

Innervation

The parietal peritoneum associated with the abdominal wall is innervated by somatic afferents carried in branches of the associated spinal nerves and is therefore sensitive to pressure, pain and temperature, and gives rise to well-localised pain. The diaphragmatic peritoneum is supplied by the phrenic nerve (C3 – C5) and the remainder of the parietal peritoneum is supplied segmentally by intercostal and lumbar nerves.

The visceral peritoneum is innervated by visceral afferents that accompany autonomic nerves back to the CNS and therefore activation gives rise to referred and poorly localised sensations of discomfort and to visceral motor activity.



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Retroperitoneal viscera

A useful mnemonic to help remember which abdominal organs are retroperitoneal is SAD PUCKER:

- Suprarenal glands
- Aorta and Inferior vena cava
- Duodenum (2nd and 3rd parts)
- Pancreas (except for the tail)
- Ureters (proximal) and Bladder
- Colon (ascending and descending)
- Kidneys
- (O)esophagus
- Rectum (lower two-thirds)

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Anatomy: Abdomen



Question 27 of 125

The arterial supply to the colon is derived predominantly from which of the following:

a Coeliac trunk

b Lumbar arteries

c Superior and inferior mesenteric arteries

d Renal artery

e Common iliac artery

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Anatomy: Abdomen

Question 27 of 125

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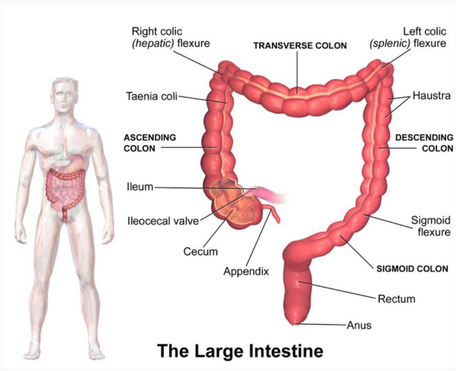
a) Coeliac trunk ✗
b) Lumbar arteries
c) Superior and inferior mesenteric arteries ✓
d) Renal artery
e) Common iliac artery

Answer

The arterial supply to the colon is derived from the superior mesenteric artery and the inferior mesenteric artery.

Notes

The large intestine extends from the distal end of the ileum to the anus, and comprises the caecum, appendix, colon, rectum and anal canal.



Blausen.com staff. "Blausen gallery 2014". Wikiversity Journal of Medicine. DOI:10.15347/wjm/2014.010. ISSN 20018762. (Own work) [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons

Colon

The colon continues from the caecum in the right groin as the ascending colon, which passes upwards through the right flank and into the right hypochondrium.

Just below the right lobe of the liver, it bends to the left forming the right colic flexure (hepatic flexure), and crosses the abdomen as the transverse colon to the left hypochondrium. The transverse colon is related superiorly to the liver, gallbladder, greater curvature of the stomach and the lateral end of the spleen.

At this point, just below the spleen, it bends downwards forming the left colic flexure (splenic flexure) and continues as the descending colon through the left flank and into the left groin. The splenic flexure is higher and more posterior than the hepatic flexure, and is attached to the diaphragm by the phrenicocolic ligament.

The colon enters the upper part of the pelvis as the sigmoid colon, which begins above the pelvic inlet and extends to the level of vertebra S3 where it is continuous with the rectum. This S-shaped structure is quite mobile except at its proximal and distal end which are attached to the descending colon and rectum respectively. Between these points, it is suspended by the sigmoid mesocolon.

The ascending and descending segments are retroperitoneal and the transverse and sigmoid segments are intraperitoneal.

Relations

Colon	Anterior relations	Posterior relations
Ascending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, right kidney
Transverse colon	Liver, gallbladder, stomach, greater omentum, anterior abdominal wall	Second part of duodenum, head of pancreas, upper end of mesentery, duodenojejunal flexure, coils of jejunum and ileum
Descending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, left kidney
Sigmoid colon	Bladder, uterus and upper vagina	Rectum, sacrum, ileum

Blood supply

The arterial supply to the colon is derived from the superior mesenteric artery (caecum, appendix, ascending colon, hepatic flexure, proximal two-thirds of transverse colon) and the inferior mesenteric artery (distal one-thirds of transverse colon, splenic flexure, descending colon, sigmoid colon).

As the terminal vessels of the superior mesenteric and inferior mesenteric artery approach the colon they split into many colic branches which anastomose with each other. These anastomoses from a continuous arterial channel which extends the length of the colon, the marginal artery.

At the junctional area of the supply of the superior and inferior mesenteric arteries, the anastomosis may not be sufficient, thus the splenic flexure is most susceptible to ischaemia.

Innervation

The visceral pain sensation from the ascending and transverse colon travels through the lesser splanchnic nerve to the T10 – T11 spinal cord segments hence pain is referred to the umbilical and hypogastric regions.

Pain from the descending and sigmoid colon is carried in the lumbar splanchnic nerves to the L1 and L2 spinal cord segments hence pain is referred to the inguinal region and thigh.

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Anatomy: Abdomen



Question 28 of 125

Which of the following is not an anatomical feature that prevents against gastric reflux:

a The diaphragmatic pinchcock effect on the oesophagus

b Intra-abdominal pressure which maintains the oesophagus in a state of collapse when empty

c The angle of His formed at the junction of the oesophagus and gastric fundus

d Gastric mucosal rosette-like folds at the gastro-oesophageal junction

e The striated lower oesophageal sphincter muscle

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Anatomy: Abdomen

Question 28 of 125

Which of the following is not an anatomical feature that prevents against gastric reflux:

a) **The diaphragmatic pinchcock effect on the oesophagus** ✖
b) Intra-abdominal pressure which maintains the oesophagus in a state of collapse when empty
c) The angle of His formed at the junction of the oesophagus and gastric fundus
d) Gastric mucosal rosette-like folds at the gastro-oesophageal junction
e) The striated lower oesophageal sphincter muscle ✔

Answer

The lower oesophageal sphincter is a physiological sphincter, formed from a high-pressure zone of smooth muscle, located at the gastro-oesophageal junction.

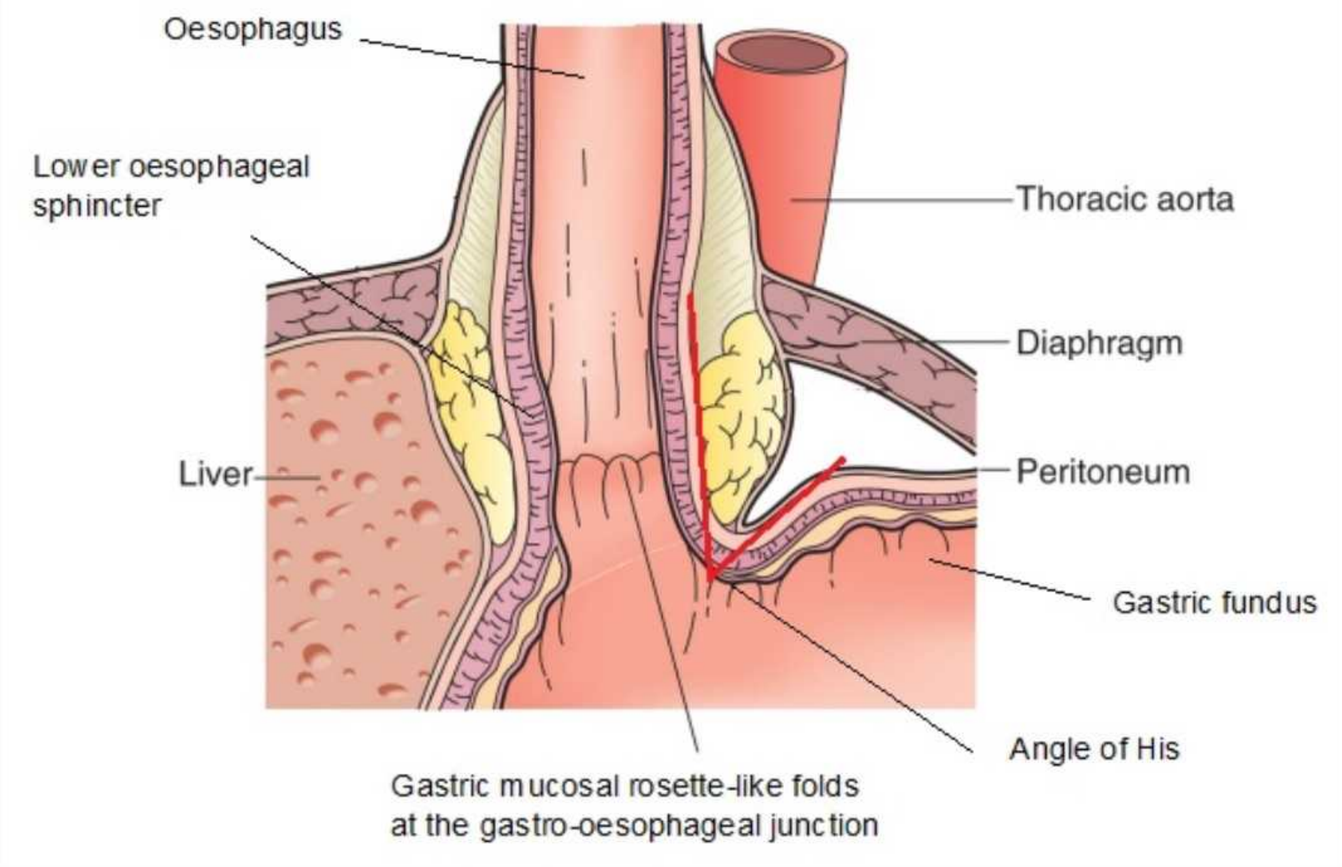
Notes

The abdominal oesophagus represents the short distal part (about 2 cm) of the oesophagus located in the abdominal cavity. Emerging through the right crus of the diaphragm at the level of vertebra T10, it passes from the oesophageal hiatus to the cardiac orifice of the stomach just left of the midline at the level of vertebra T11.

The lower oesophageal sphincter is a physiological sphincter located at the gastro-oesophageal junction.

Anatomical factors that help guard against gastric reflux include:

- The diaphragmatic pinchcock effect where at the oesophageal hiatus, right crural fibres exert pressure on the oesophageal wall and serve as an extrinsic sphincter
- The lower oesophageal sphincter which is a high-pressure zone of smooth muscle in the oesophageal wall maintained in a state of tonic contraction (except during swallowing, belching or vomiting)
- Intra-abdominal pressure which maintains the oesophagus in a state of collapse when empty
- The angle of His formed at the junction of the oesophagus and the gastric fundus, which together with the posterolateral position of the gastric fundus, minimises contact of gastric content with the gastro-oesophageal junction
- The gastric mucosal rosette-like folds formed at the gastro-oesophageal junction which compress against each other with increased intraabdominal pressure to prevent reflux



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Anatomy: Abdomen



Question 29 of 125

Which of the following structures does not make up part of the stomach bed:

a Pancreas

b Transverse mesocolon

c Left kidney

d Abdominal aorta

e Spleen

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Anatomy: Abdomen

Question 29 of 125

Which of the following structures does not make up part of the stomach bed:

a) Pancreas ✗
b) Transverse mesocolon
c) Left kidney
d) Abdominal aorta ✓
e) Spleen

Answer

The stomach lies anterior to the stomach bed formed by the diaphragm, the pancreas, the transverse colon and mesocolon, the left colic flexure, the left kidney, the left adrenal gland and the spleen.

Notes

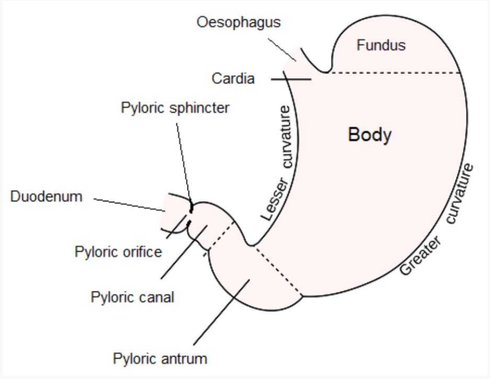
The stomach is the most dilated part of the gastrointestinal tract and has a J-like shape. The stomach is in the epigastric, umbilical and left hypochondriac regions of the abdomen. It is an intraperitoneal organ.

Anatomical distinctions

The stomach is divided into four regions:

- the cardia which surrounds the opening of the oesophagus into the stomach
- the fundus which is the area above the level of the cardiac orifice
- the body which is the largest central region of the stomach
- the pyloric part which is divided into the pyloric antrum and the pyloric canal which opens into the duodenum.

The most distal portion of the pyloric canal contains a thickened ring of gastric circular muscle, the pyloric sphincter that surrounds the distal pyloric orifice. The pyloric orifice is just to the right of the midline in the transpyloric plane. The pyloric sphincter controls the exit of chyme from the stomach into the duodenum. The sphincter is constricted by sympathetic stimulation and relaxed by parasympathetic action. Parasympathetic fibres in the vagus nerve are also secretomotor to gastric glands and motor to muscular wall of stomach.



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Relations

The stomach lies inferior to the diaphragm.

The stomach lies posterior to:

- the anterior abdominal wall
- the left costal margin
- the left lobe of the liver

The stomach lies anterior to the stomach bed formed by:

- the diaphragm
- the pancreas
- the transverse mesocolon
- the left colic flexure
- the left kidney
- the left adrenal gland
- the spleen

Blood supply

The arterial supply to the stomach is derived from all three branches (left gastric, splenic and common hepatic branches) of the coeliac trunk.

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Anatomy: Abdomen



Question 30 of 125

Which of the following best describes the location of the omental bursa:

a Inferior to the transverse mesocolon

b To the right of the oblique attachment of the mesentery

c Posterior to the stomach and liver

d Posterior to the pancreas

e Anterior to the stomach and liver

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Anatomy: Abdomen

Question 30 of 125

Which of the following best describes the location of the omental bursa:

a) **Inferior to the transverse mesocolon** ✗
b) To the right of the oblique attachment of the mesentery
c) Posterior to the stomach and liver ✓
d) Posterior to the pancreas
e) Anterior to the stomach and liver

Answer

The omental bursa (lesser sac) is a smaller subdivision of the peritoneal cavity posterior to the stomach and liver and anterior to the pancreas, and is continuous with the greater sac through the epiploic foramen.

Notes

Structure	Key anatomy
Peritoneal cavity	Divided into greater and lesser sacs
Greater sac	Divided into supracolic and infracolic compartments by transverse mesocolon, compartments connected by paracolic gutters
Supracolic compartment	Contains stomach, liver and spleen, lies under cover of costal limits of thoracic cage
Infracolic compartment	Divided into left and right parts by oblique attachment of mesentery, contains small intestine and ascending/descending colon, continuous with pelvic cavity
Lesser sac (omental bursa	Lies posterior to stomach and liver and anterior to pancreas, continuous with greater sac through epiploic foramen
Greater omentum	Descends from greater curvature of stomach and first part of duodenum, drapes inferiorly over transverse colon, jejunum and ileum, folds back up and ascends to adhere to transverse colon/mesocolon before arriving at posterior abdominal wall
Lesser omentum	Extends from lesser curvature of stomach and first part of duodenum to inferior surface of liver
Mesentery	Connects jejunum and ileus to posterior abdominal wall, attaches superiorly to duodenojejunal junction and passes oblique downwards and to the right to end at ileocecal junction
Transverse mesocolon	Connects transverse colon to posterior abdominal wall, leaves posterior abdominal wall across anterior surface of head and body of pancreas and passes outwards to surround transverse colon
Sigmoid mesocolon	Connects sigmoid colon to abdominal wall, V-shaped fold with apex near division of left common iliac artery, left limb descending along medial border of left psoas major muscle and right limb descending into pelvis to end at vertebral level S3

Compartments of the peritoneal cavity

The peritoneal cavity is divided into the greater sac and the omental bursa (lesser sac).

The greater sac accounts for most of the space in the peritoneal cavity, beginning superiorly at the diaphragm and continuing inferiorly in the pelvic cavity. It is further divided into two compartments by the transverse mesocolon:

- The supracolic compartment lies above the transverse mesocolon and contains the stomach, liver and spleen. It lies largely under cover of the costal limits of the thoracic cage.
- The infracolic compartment lies below the transverse mesocolon, is divided into left and right parts by the oblique attachment of the mesentery and contains the small intestine and the ascending and descending colon. The left infracolic compartment is continuous with the pelvic cavity.

The supracolic and infracolic compartments are connected by the paracolic gutters which lie between the posterolateral abdominal wall and the lateral aspect of the ascending or descending colon.

The omental bursa (lesser sac) is a smaller subdivision of the peritoneal cavity posterior to the stomach and liver and anterior to the pancreas, and is continuous with the greater sac through the epiploic foramen.

Omenta

The omenta are double layers of peritoneum that extends from the stomach and proximal part of the duodenum to other organs.

The greater omentum descends from the greater curvature of the stomach and first part of the duodenum, drapes inferiorly over the transverse colon and the coils of the jejunum and ileum, then folds back up posteriorly and ascends to become adherent to the peritoneum on the superior surface of the transverse colon and the anterior layer of the transverse mesocolon before arriving at the posterior abdominal wall.

The lesser omentum is considerably smaller and extends from the lesser curvature of the stomach and the first part of the duodenum to the inferior surface of the liver.

The greater omentum is often referred to as the 'policeman of the abdomen' because of its apparent ability to migrate to any inflamed area and wrap itself around the organ to wall off inflammation. The greater omentum is also an important site for metastatic tumour spread; direct omental spread by a transcoelomic route is common for carcinoma of the ovary.

Mesenteries

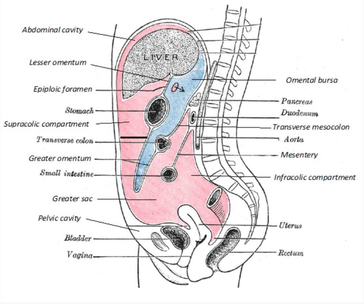
Mesenteries are peritoneal folds that attach viscera to the posterior abdominal wall. They allow some movement and provide a conduit for vessels, nerves and lymphatics to reach the viscera and include:

- the mesentery – associated with parts of the small intestine
- the transverse mesocolon – associated with transverse colon
- the sigmoid mesocolon – associated with the sigmoid colon.

The mesentery is a large, fan-shaped, double-layered fold of peritoneum that connects the jejunum and ileum to the posterior abdominal wall. Its superior attachment is at the duodenojejunal junction, just to the left of the upper lumbar part of the vertebral column. It passes obliquely downwards and to the right, ending at the ileocaecal junction near the upper border of the right sacroiliac joint.

The transverse mesocolon is a fold of peritoneum that connects the transverse colon to the posterior abdominal wall. It leaves the posterior abdominal wall across the anterior surface of the head and body of the pancreas and passes outwards to surround the transverse colon. Its anterior layer is adherent to the posterior layer of the greater omentum.

The sigmoid mesocolon is an inverted V-shaped peritoneal fold that attaches the sigmoid colon to the abdominal wall. The apex of the V is near the division of the left common iliac artery, with the left limb of the descending V along the medial border of the left psoas major muscle, and the right limb descending into the pelvis to end at the level of vertebra S3.



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Anatomy: Abdomen



Question 31 of 125

A 35 year old male is brought to ED with a knife wound. Imaging shows damage to the superior mesenteric artery. Which of the following structures would most likely be affected by this injury:

a Ascending and descending colon

b Ascending and transverse colon

c Transverse and descending colon

d Descending and sigmoid colon

e Transverse and sigmoid colon

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Anatomy: Abdomen

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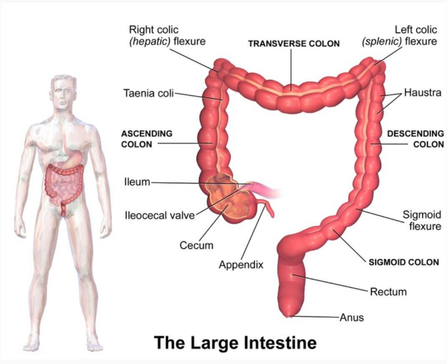
a) **Ascending and descending colon** ✗
b) Ascending and transverse colon ✓
c) Transverse and descending colon
d) Descending and sigmoid colon
e) Transverse and sigmoid colon

Answer

The superior mesenteric artery supplies the midgut structures including the caecum, appendix, ascending colon and proximal two-thirds of the transverse colon. The descending colon and sigmoid colon are supplied by the inferior mesenteric artery.

Notes

The large intestine extends from the distal end of the ileum to the anus, and comprises the caecum, appendix, colon, rectum and anal canal.



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Colon

The colon continues from the caecum in the right groin as the ascending colon, which passes upwards through the right flank and into the right hypochondrium.

Just below the right lobe of the liver, it bends to the left forming the right colic flexure (hepatic flexure), and crosses the abdomen as the transverse colon to the left hypochondrium. The transverse colon is related superiorly to the liver, gallbladder, greater curvature of the stomach and the lateral end of the spleen.

At this point, just below the spleen, it bends downwards forming the left colic flexure (splenic flexure) and continues as the descending colon through the left flank and into the left groin. The splenic flexure is higher and more posterior than the hepatic flexure, and is attached to the diaphragm by the phrenicocolic ligament.

The colon enters the upper part of the pelvis as the sigmoid colon, which begins above the pelvic inlet and extends to the level of vertebra S3 where it is continuous with the rectum. This S-shaped structure is quite mobile except at its proximal and distal end which are attached to the descending colon and rectum respectively. Between these points, it is suspended by the sigmoid mesocolon.

The ascending and descending segments are retroperitoneal and the transverse and sigmoid segments are intraperitoneal.

Relations

Colon	Anterior relations	Posterior relations
Ascending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, right kidney
Transverse colon	Liver, gallbladder, stomach, greater omentum, anterior abdominal wall	Second part of duodenum, head of pancreas, upper end of mesentery, duodenojejunal flexure, coils of jejunum and ileum
Descending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, left kidney
Sigmoid colon	Bladder, uterus and upper vagina	Rectum, sacrum, ileum

Blood supply

The arterial supply to the colon is derived from the superior mesenteric artery (caecum, appendix, ascending colon, hepatic flexure, proximal two-thirds of transverse colon) and the inferior mesenteric artery (distal one-thirds of transverse colon, splenic flexure, descending colon, sigmoid colon).

As the terminal vessels of the superior mesenteric and inferior mesenteric artery approach the colon they split into many colic branches which anastomose with each other. These anastomoses from a continuous arterial channel which extends the length of the colon, the marginal artery.

At the junctional area of the supply of the superior and inferior mesenteric arteries, the anastomosis may not be sufficient, thus the splenic flexure is most susceptible to ischaemia.

Innervation

The visceral pain sensation from the ascending and transverse colon travels through the lesser splanchnic nerve to the T10 – T11 spinal cord segments hence pain is referred to the umbilical and hypogastric regions.

Pain from the descending and sigmoid colon is carried in the lumbar splanchnic nerves to the L1 and L2 spinal cord segments hence pain is referred to the inguinal region and thigh.

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Anatomy: Abdomen



Question 32 of 125

The rectus sheath is formed by which of the following:

a the thoracolumbar fascia

b the aponeuroses of the external and internal oblique

c the aponeuroses of the external oblique, internal oblique and transversus abdominis

d the transversalis fascia

e the tendinous intersections of the rectus abdominis

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Anatomy: Abdomen



Question 32 of 125

The rectus sheath is formed by which of the following:

a) the thoracolumbar fascia ✗
b) the aponeuroses of the external and internal oblique
c) the aponeuroses of the external oblique, internal oblique and transversus abdominis ✓
d) the transversalis fascia
e) the tendinous intersections of the rectus abdominis

Answer

Notes

The rectus sheath is formed by the aponeuroses of the three flat anterior abdominal wall muscles.

The anterior wall of the sheath is formed by the aponeurosis of the external oblique and half of the aponeurosis of the internal oblique (which splits at the lateral margin of the rectus abdominis). The posterior wall of the sheath is formed by the other half of the aponeurosis of the internal oblique and by the aponeurosis of the transversus abdominis.

The rectus sheath completely encloses the upper three-quarters of the rectus abdominis and covers the anterior surface of the lower one-quarter of the muscle; at this point, the anterior wall is formed by the aponeuroses of all three muscles, there is no posterior wall to the rectus sheath and the rectus abdominis is in direct contact with the transversalis fascia; marking this point of transition is the arcuate line.

The rectus sheath also encloses the pyramidalis muscle, the intercostal nerves of T7 – T12 and the superior and inferior epigastric arteries.

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Anatomy: Abdomen



Question 33 of 125

The termination of the abdominal aorta can be visualised on the anterior abdominal wall by a point:

a About 2.5 cm above the umbilicus

b About 2.5 cm below the umbilicus

c Halfway between the xiphisternum and the umbilicus

d Halfway between the umbilicus and the pubic symphysis

e About 2.5 cm above the deep inguinal ring

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Anatomy: Abdomen

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The termination of the abdominal aorta can be visualised on the anterior abdominal wall by a point:

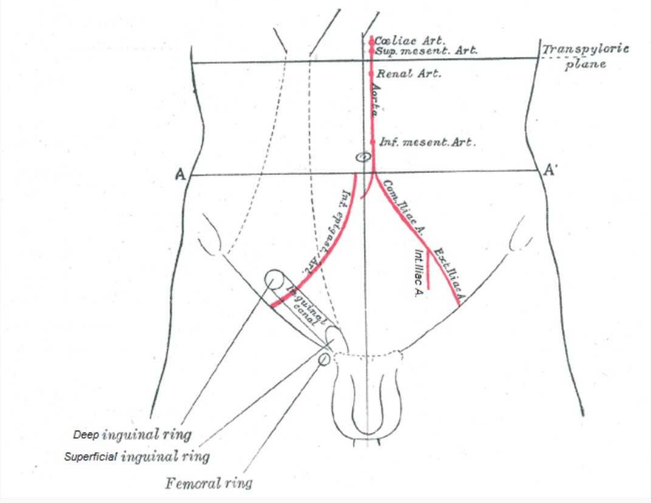
a) **About 2.5 cm above the umbilicus** ✗
b) About 2.5 cm below the umbilicus ✓
c) Halfway between the xiphisternum and the umbilicus
d) Halfway between the umbilicus and the pubic symphysis
e) About 2.5 cm above the deep inguinal ring

Answer

The main terminal branches of the abdominal aorta are the two common iliac arteries. This bifurcation can be visualised on the anterior abdominal wall as a point approximately 2.5 cm below the umbilicus.

Notes

The abdominal aorta begins at the aortic hiatus of the diaphragm, anterior to the lower border of vertebra T12. It descends through the abdomen, anterior to the vertebral bodies, and by the time it ends at the level of vertebra L4 it is slightly to the left of the midline. The main terminal branches of the abdominal aorta are the two common iliac arteries. This bifurcation can be visualised on the anterior abdominal wall as a point approximately 2.5 cm below the umbilicus.



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The abdominal aorta gives rise to:

- three anterior unpaired visceral branches
  - the coeliac trunk supplying the abdominal foregut (upper border of L1 vertebra)
  - the superior mesenteric artery supplying the abdominal midgut (lower border of L1 vertebra)
  - the inferior mesenteric artery supplying the abdominal hindgut (L3 vertebra)
- three lateral paired visceral branches
  - the middle suprarenal arteries
  - the renal arteries (L2 vertebra)
  - the gonadal arteries
- posterior parietal branches
  - the inferior phrenic arteries (paired)
  - the lumbar arteries (paired)
  - the median sacral artery (single)
- two terminal branches
  - left common iliac artery
  - right common iliac artery

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Anatomy: Abdomen



Question 34 of 125

The deep inguinal ring is an 'opening' in which of the following structures:

a External oblique aponeurosis

b Internal oblique aponeurosis

c Transversus abdominis aponeurosis

d Rectus abdominis aponeurosis

e Transversalis fascia

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Anatomy: Abdomen

Question 34 of 125

The deep inguinal ring is an 'opening' in which of the following structures:

a) **External oblique aponeurosis** ✗
b) Internal oblique aponeurosis
c) Transversus abdominis aponeurosis
d) Rectus abdominis aponeurosis
e) Transversalis fascia ✓

Answer

The deep inguinal ring, the opening in the transversalis fascia, is the beginning of the inguinal canal.

Notes

Space	Inguinal canal
Position	Between deep and superficial inguinal rings, just above and parallel to lower half of inguinal ligament
Anterior wall	Formed by external oblique aponeurosis (reinforced by internal oblique muscle laterally)
Posterior wall	Formed by transversalis fascia (reinforced by conjoint tendon medially)
Roof	Formed by transversus abdominis and internal oblique muscles
Floor	Formed by medial one-half of inguinal ligament (reinforced by lacunar ligament medially)
Deep inguinal ring	Opening in transversalis fascia, located just superior to mid-inguinal point (midway between ASIS and pubic symphysis)
Superficial inguinal ring	Opening in external oblique aponeurosis, located just superior to pubic tubercle
Contents	Genital branch of genitofemoral nerve, spermatic cord, round ligament, ilioinguinal nerve

Position

The inguinal canal is a slit-like passage that extends in a downwards and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the deep inguinal ring and continues for approximately 4 cm, ending at the superficial inguinal ring.

Roof, walls and floor

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle, and reinforced by the internal oblique muscle laterally.

The posterior wall of the inguinal canal is formed along its entire length by the transversalis fascia and reinforced by the conjoint tendon medially.

The roof of the inguinal canal is formed by arching fibres of the transversus abdominis and internal oblique muscles.

The floor of the inguinal canal is formed by the medial one-half of the inguinal ligament, reinforced medially by the lacunar ligament.

Deep inguinal ring

The deep inguinal ring, the opening in the transversalis fascia, is the beginning of the inguinal canal.

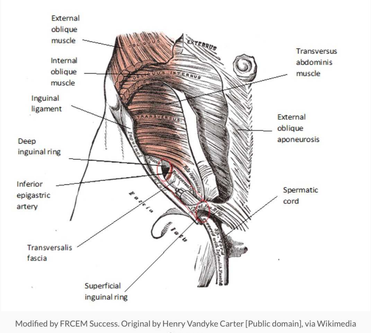
The deep inguinal ring is located just superior to a point midway between the anterior superior iliac spine and the pubic symphysis (the mid-inguinal point). N.B. Some sources state it is located at a slightly different site, just superior to a point midway between the anterior superior iliac spine and the pubic tubercle (the midpoint of the inguinal ligament).

It lies just above the inguinal ligament and immediately lateral to the inferior epigastric vessels; the femoral artery can be palpated in the same position but below the inguinal ligament.

Superficial inguinal ring

The superficial inguinal ring is the end of the inguinal canal.

The superficial inguinal ring is located just superior to the pubic tubercle. It is a triangular opening in the aponeurosis of the external oblique, with its apex pointing superolaterally and its base formed by the pubic crest.



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Contents

The inguinal canal contains:

- the genital branch of the genitofemoral nerve (within the spermatic cord in men)
- the spermatic cord in men
- the round ligament in women
- the ilioinguinal nerve (passes through part of the canal, exiting the superficial inguinal ring with the other contents)

Inguinal hernia

An inguinal hernia is the protrusion of a peritoneal sac through a weakened part of the abdominal wall in the groin.

Hernia	Indirect inguinal hernia	Direct inguinal hernia
Aetiology	Congenital – patent processus vaginalis	Acquired – weakened abdominal musculature
Mechanism	Peritoneal sac herniates through deep inguinal ring	Peritoneal sac herniates directly through posterior wall of inguinal canal
Relation to inferior epigastric vessels	Lateral to inferior epigastric vessels	Medial to inferior epigastric vessels

In indirect inguinal hernias, the most common type, the peritoneal sac enters the inguinal canal by passing through the deep inguinal ring, due to a patent embryonic processus vaginalis. If the entire processus vaginalis remains patent, the peritoneal sac may traverse the length of the canal, exit the superficial inguinal ring and continue into the scrotum or labia majora.

In direct inguinal hernias, the peritoneal sac passes directly through the posterior wall of the inguinal canal. It usually occurs when abdominal musculature has been weakened, in older men, following surgery or due to persistent raised intra-abdominal pressure. This type of hernia does not traverse the inguinal canal, but may still exit the superficial inguinal ring to enter the scrotum.

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Anatomy: Abdomen



Question 35 of 125

Which of the following parts of the pancreas is intraperitoneal:

a Head

b Neck

c Body

d Uncinate process

e Tail

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Anatomy: Abdomen

Question 35 of 125

Which of the following parts of the pancreas is intraperitoneal:

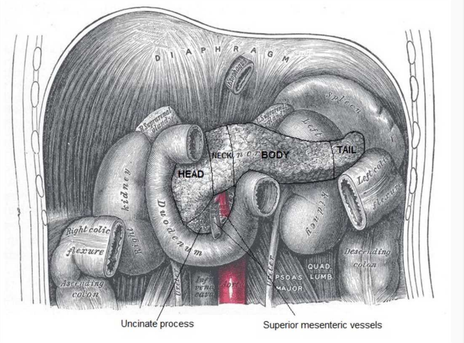
a) Head ✖
b) Neck
c) Body
d) Uncinate process
e) Tail ✔

Answer

The pancreas is a retroperitoneal organ (except for a small part of its tail) and consists of a head, uncinate process, neck, body and tail. The tail passes between layers of the splenorenal ligament.

Notes

The pancreas lies mostly posterior to the stomach. It extends across the posterior abdominal wall from the duodenum on the right, to the spleen on the left. It lies in the epigastric region and left hypochondrium. The pancreas is a retroperitoneal organ (except for a small part of its tail) and consists of a head, uncinate process, neck, body and tail.

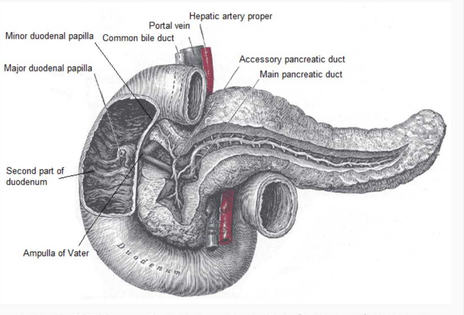


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Relations

- The head of the pancreas lies within the C-shaped concavity of the duodenum. The head is related anteriorly to the first part of the duodenum, the transverse colon and coils of jejunum and posteriorly to the common bile duct and the inferior vena cava and the termination of the renal veins.
- The uncinate process projects from the lower part of the head and passes posterior to the superior mesenteric vessels.
- The neck is anterior to the superior mesenteric vessels. Posterior to the neck of the pancreas, the superior mesenteric and splenic veins join to form the portal vein.
- The body is elongated and extends from the neck to the tail of the pancreas in the transpyloric plane (at the level of vertebra L1) to lie behind the stomach and to the left of the superior mesenteric vessels.
- The intraperitoneal tail passes between layers of the splenorenal ligament. It is related to the left kidney posteriorly, the hilum of the spleen laterally, the left colic flexure inferiorly and the stomach anteriorly.

The pancreatic duct begins in the tail of the pancreas and passes to the right, through the body and to the head where it turns inferiorly and joins the bile duct forming the hepatopancreatic ampulla (ampulla of Vater) which enters the second part of the duodenum at the major duodenal papilla. The accessory pancreatic duct empties into the duodenum just above the major duodenal papilla at the minor duodenal papilla.



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Blood supply

The arterial supply to the pancreas is primarily derived from the splenic artery from the coeliac trunk, assisted by branches from the gastroduodenal artery (from the common hepatic artery from the coeliac trunk), and from the superior mesenteric artery.

Venous drainage of the head of the pancreas is via pancreaticoduodenal veins into the superior mesenteric vein and portal vein. Venous drainage of the body and tail of the pancreas is via pancreatic veins into the splenic vein.

Lymphatics

Lymphatics draining the pancreas empty into the pancreaticosplenic nodes and the pyloric nodes, which in turn drain into the superior mesenteric and celiac pre-aortic lymph nodes.

Innervation

Visceral afferent fibres travel in the greater and lesser splanchnic nerves. The segmental level of innervation is T6 – T10. Pain typically radiates to the middle of the back due to irritation of the parietal peritoneum covering the pancreas.

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Anatomy: Abdomen



Question 36 of 125

A 49 year old man presents to ED with a few months history of abdominal pain, weight loss and jaundice. Imaging shows a tumour in the uncinate process of the pancreas. Which of the following structures is most likely compressed by this tumour:

a Cystic duct

b Main pancreatic duct

c Superior mesenteric artery

d Portal vein

e Splenic artery

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Anatomy: Abdomen

Question 36 of 125

A 49 year old man presents to ED with a few months history of abdominal pain, weight loss and jaundice. Imaging shows a tumour in the uncinate process of the pancreas. Which of the following structures is most likely compressed by this tumour:

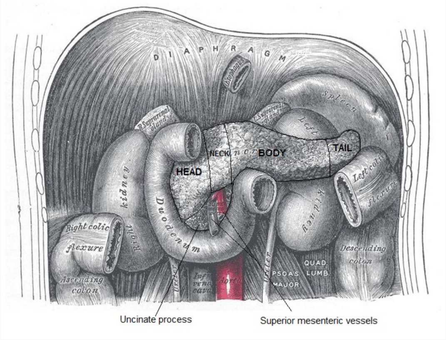
a) Cystic duct ✗
b) Main pancreatic duct
c) Superior mesenteric artery ✓
d) Portal vein
e) Splenic artery

Answer

The uncinate process of the pancreas is a projection of the lower part of the head to the left behind the superior mesenteric vessels.

Notes

The pancreas lies mostly posterior to the stomach. It extends across the posterior abdominal wall from the duodenum on the right, to the spleen on the left. It lies in the epigastric region and left hypochondrium. The pancreas is a retroperitoneal organ (except for a small part of its tail) and consists of a head, uncinate process, neck, body and tail.

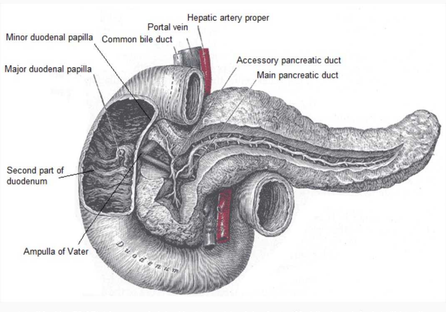


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Relations

- The head of the pancreas lies within the C-shaped concavity of the duodenum. The head is related anteriorly to the first part of the duodenum, the transverse colon and coils of jejunum and posteriorly to the common bile duct and the inferior vena cava and the termination of the renal veins.
- The uncinate process projects from the lower part of the head and passes posterior to the superior mesenteric vessels.
- The neck is anterior to the superior mesenteric vessels. Posterior to the neck of the pancreas, the superior mesenteric and splenic veins join to form the portal vein.
- The body is elongated and extends from the neck to the tail of the pancreas in the transpyloric plane (at the level of vertebra L1) to lie behind the stomach and to the left of the superior mesenteric vessels.
- The intraperitoneal tail passes between layers of the splenorenal ligament. It is related to the left kidney posteriorly, the hilum of the spleen laterally, the left colic flexure inferiorly and the stomach anteriorly.

The pancreatic duct begins in the tail of the pancreas and passes to the right, through the body and to the head where it turns inferiorly and joins the bile duct forming the hepatopancreatic ampulla (ampulla of Vater) which enters the second part of the duodenum at the major duodenal papilla. The accessory pancreatic duct empties into the duodenum just above the major duodenal papilla at the minor duodenal papilla.



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Blood supply

The arterial supply to the pancreas is primarily derived from the splenic artery from the coeliac trunk, assisted by branches from the gastroduodenal artery (from the common hepatic artery from the coeliac trunk), and from the superior mesenteric artery.

Venous drainage of the head of the pancreas is via pancreaticoduodenal veins into the superior mesenteric vein and portal vein. Venous drainage of the body and tail of the pancreas is via pancreatic veins into the splenic vein.

Lymphatics

Lymphatics draining the pancreas empty into the pancreaticosplenic nodes and the pyloric nodes, which in turn drain into the superior mesenteric and celiac pre-aortic lymph nodes.

Innervation

Visceral afferent fibres travel in the greater and lesser splanchnic nerves. The segmental level of innervation is T6 – T10. Pain typically radiates to the middle of the back due to irritation of the parietal peritoneum covering the pancreas.

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Anatomy: Abdomen



Question 37 of 125

The deep inguinal ring is located at which of the following sites:

a Immediately superficial to the femoral artery

b Superior to a point midway between the iliac crest and the pubic symphysis

c Inferior to a point midway between the anterior superior iliac spine and the pubic tubercle

d Just superior to the pubic tubercle

e Superior to the mid-inguinal point

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Anatomy: Abdomen

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The deep inguinal ring is located at which of the following sites:

a) **Immediately superficial to the femoral artery** ✗
b) Superior to a point midway between the iliac crest and the pubic symphysis
c) Inferior to a point midway between the anterior superior iliac spine and the pubic tubercle
d) Just superior to the pubic tubercle
e) Superior to the mid-inguinal point ✓

Answer

The deep inguinal ring is located just superior to a point midway between the anterior superior iliac spine and the pubic symphysis (the mid-inguinal point). N.B. Some sources state it is located at a slightly different site, just superior to a point midway between the anterior superior iliac spine and the pubic tubercle (the midpoint of the inguinal ligament).

Notes

Space	Inguinal canal
Position	Between deep and superficial inguinal rings, just above and parallel to lower half of inguinal ligament
Anterior wall	Formed by external oblique aponeurosis (reinforced by internal oblique muscle laterally)
Posterior wall	Formed by transversalis fascia (reinforced by conjoint tendon medially)
Roof	Formed by transversus abdominis and internal oblique muscles
Floor	Formed by medial one-half of inguinal ligament (reinforced by lacunar ligament medially)
Deep inguinal ring	Opening in transversalis fascia, located just superior to mid-inguinal point (midway between ASIS and pubic symphysis)
Superficial inguinal ring	Opening in external oblique aponeurosis, located just superior to pubic tubercle
Contents	Genital branch of genitofemoral nerve, spermatic cord, round ligament, ilioinguinal nerve

Position

The inguinal canal is a slit-like passage that extends in a downwards and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the deep inguinal ring and continues for approximately 4 cm, ending at the superficial inguinal ring.

Roof, walls and floor

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle, and reinforced by the internal oblique muscle laterally.

The posterior wall of the inguinal canal is formed along its entire length by the transversalis fascia and reinforced by the conjoint tendon medially.

The roof of the inguinal canal is formed by arching fibres of the transversus abdominis and internal oblique muscles.

The floor of the inguinal canal is formed by the medial one-half of the inguinal ligament, reinforced medially by the lacunar ligament.

Deep inguinal ring

The deep inguinal ring, the opening in the transversalis fascia, is the beginning of the inguinal canal.

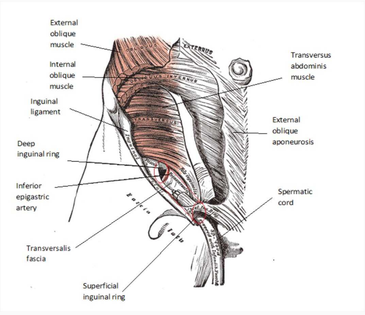
The deep inguinal ring is located just superior to a point midway between the anterior superior iliac spine and the pubic symphysis (the mid-inguinal point). N.B. Some sources state it is located at a slightly different site, just superior to a point midway between the anterior superior iliac spine and the pubic tubercle (the midpoint of the inguinal ligament).

It lies just above the inguinal ligament and immediately lateral to the inferior epigastric vessels; the femoral artery can be palpated in the same position but below the inguinal ligament.

Superficial inguinal ring

The superficial inguinal ring is the end of the inguinal canal.

The superficial inguinal ring is located just superior to the pubic tubercle. It is a triangular opening in the aponeurosis of the external oblique, with its apex pointing superolaterally and its base formed by the pubic crest.



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Contents

The inguinal canal contains:

- the genital branch of the genitofemoral nerve (within the spermatic cord in men)
- the spermatic cord in men
- the round ligament in women
- the ilioinguinal nerve (passes through part of the canal, exiting the superficial inguinal ring with the other contents)

Inguinal hernia

An inguinal hernia is the protrusion of a peritoneal sac through a weakened part of the abdominal wall in the groin.

Hernia	Indirect inguinal hernia	Direct inguinal hernia
Aetiology	Congenital – patent processus vaginalis	Acquired – weakened abdominal musculature
Mechanism	Peritoneal sac herniates through deep inguinal ring	Peritoneal sac herniates directly through posterior wall of inguinal canal
Relation to inferior epigastric vessels	Lateral to inferior epigastric vessels	Medial to inferior epigastric vessels

In indirect inguinal hernias, the most common type, the peritoneal sac enters the inguinal canal by passing through the deep inguinal ring, due to a patent embryonic processus vaginalis. If the entire processus vaginalis remains patent, the peritoneal sac may traverse the length of the canal, exit the superficial inguinal ring and continue into the scrotum or labia majora.

In direct inguinal hernias, the peritoneal sac passes directly through the posterior wall of the inguinal canal. It usually occurs when abdominal musculature has been weakened, in older men, following surgery or due to persistent raised intra-abdominal pressure. This type of hernia does not traverse the inguinal canal, but may still exit the superficial inguinal ring to enter the scrotum.

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Anatomy: Abdomen



Question 38 of 125

The pancreas occupies which of the following abdominal regions:

a Left hypochondrium and left flank

b Left hypochondrium

c Right hypochondrium and epigastrium

d Left hypochondrium and epigastrium

e Epigastrium and umbilicus

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Anatomy: Abdomen

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The pancreas occupies which of the following abdominal regions:

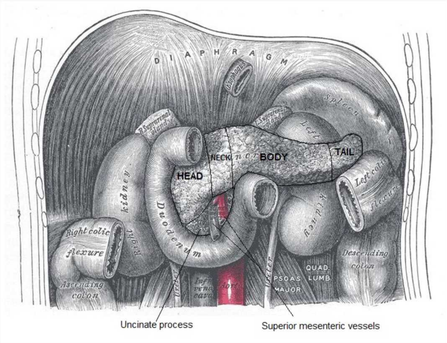
a) **Left hypochondrium and left flank** ✗
b) Left hypochondrium
c) Right hypochondrium and epigastrium
d) Left hypochondrium and epigastrium ✓
e) Epigastrium and umbilicus

Answer

The pancreas lies mostly posterior to the stomach. It extends across the posterior abdominal wall from the duodenum on the right, to the spleen on the left. It lies in the epigastric region and left hypochondrium.

Notes

The pancreas lies mostly posterior to the stomach. It extends across the posterior abdominal wall from the duodenum on the right, to the spleen on the left. It lies in the epigastric region and left hypochondrium. The pancreas is a retroperitoneal organ (except for a small part of its tail) and consists of a head, uncinate process, neck, body and tail.

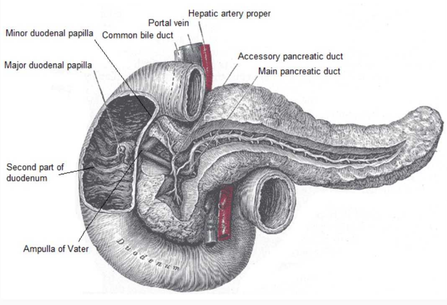


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Relations

- The head of the pancreas lies within the C-shaped concavity of the duodenum. The head is related anteriorly to the first part of the duodenum, the transverse colon and coils of jejunum and posteriorly to the common bile duct and the inferior vena cava and the termination of the renal veins.
- The uncinate process projects from the lower part of the head and passes posterior to the superior mesenteric vessels.
- The neck is anterior to the superior mesenteric vessels. Posterior to the neck of the pancreas, the superior mesenteric and splenic veins join to form the portal vein.
- The body is elongated and extends from the neck to the tail of the pancreas in the transpyloric plane (at the level of vertebra L1) to lie behind the stomach and to the left of the superior mesenteric vessels.
- The intraperitoneal tail passes between layers of the splenorenal ligament. It is related to the left kidney posteriorly, the hilum of the spleen laterally, the left colic flexure inferiorly and the stomach anteriorly.

The pancreatic duct begins in the tail of the pancreas and passes to the right, through the body and to the head where it turns inferiorly and joins the bile duct forming the hepatopancreatic ampulla (ampulla of Vater) which enters the second part of the duodenum at the major duodenal papilla. The accessory pancreatic duct empties into the duodenum just above the major duodenal papilla at the minor duodenal papilla.



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Blood supply

The arterial supply to the pancreas is primarily derived from the splenic artery from the coeliac trunk, assisted by branches from the gastroduodenal artery (from the common hepatic artery from the coeliac trunk), and from the superior mesenteric artery.

Venous drainage of the head of the pancreas is via pancreaticoduodenal veins into the superior mesenteric vein and portal vein. Venous drainage of the body and tail of the pancreas is via pancreatic veins into the splenic vein.

Lymphatics

Lymphatics draining the pancreas empty into the pancreaticosplenic nodes and the pyloric nodes, which in turn drain into the superior mesenteric and celiac pre-aortic lymph nodes.

Innervation

Visceral afferent fibres travel in the greater and lesser splanchnic nerves. The segmental level of innervation is T6 – T10. Pain typically radiates to the middle of the back due to irritation of the parietal peritoneum covering the pancreas.

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Anatomy: Abdomen



Question 39 of 125

A 49 year old known alcoholic presents to ED complaining of acute severe epigastric pain. X-ray shows pneumoperitoneum and further imaging demonstrates a perforating peptic ulcer in the posterior wall of the stomach. Where would peritonitis most likely develop initially:

a Greater sac

b Supracolic compartment

c Omental bursa

d Infracolic compartment

e Hepatorenal space

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Anatomy: Abdomen

Question 39 of 125

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a) Greater sac ✗
b) Supracolic compartment
c) Omental bursa ✓
d) Infracolic compartment
e) Hepatorenal space

Answer

The omental bursa is located directly posterior to the stomach and therefore would be the most likely space to develop peritonitis initially. The hepatorenal space is the area posterior t the liver and anterior to the right kidney.

Notes

Structure	Key anatomy
Peritoneal cavity	Divided into greater and lesser sacs
Greater sac	Divided into supracolic and infracolic compartments by transverse mesocolon, compartments connected by paracolic gutters
Supracolic compartment	Contains stomach, liver and spleen, lies under cover of costal limits of thoracic cage
Infracolic compartment	Divided into left and right parts by oblique attachment of mesentery, contains small intestine and ascending/descending colon, continuous with pelvic cavity
Lesser sac (omental bursa	Lies posterior to stomach and liver and anterior to pancreas, continuous with greater sac through epiploic foramen
Greater omentum	Descends from greater curvature of stomach and first part of duodenum, drapes inferiorly over transverse colon, jejunum and ileum, folds back up and ascends to adhere to transverse colon/mesocolon before arriving at posterior abdominal wall
Lesser omentum	Extends from lesser curvature of stomach and first part of duodenum to inferior surface of liver
Mesentery	Connects jejunum and ileus to posterior abdominal wall, attaches superiorly to duodenojejunal junction and passes oblique downwards and to the right to end at ileocecal junction
Transverse mesocolon	Connects transverse colon to posterior abdominal wall, leaves posterior abdominal wall across anterior surface of head and body of pancreas and passes outwards to surround transverse colon
Sigmoid mesocolon	Connects sigmoid colon to abdominal wall, V-shaped fold with apex near division of left common iliac artery, left limb descending along medial border of left psoas major muscle and right limb descending into pelvis to end at vertebral level S3

Compartments of the peritoneal cavity

The peritoneal cavity is divided into the greater sac and the omental bursa (lesser sac).

The greater sac accounts for most of the space in the peritoneal cavity, beginning superiorly at the diaphragm and continuing inferiorly in the pelvic cavity. It is further divided into two compartments by the transverse mesocolon:

- The supracolic compartment lies above the transverse mesocolon and contains the stomach, liver and spleen. It lies largely under cover of the costal limits of the thoracic cage.
- The infracolic compartment lies below the transverse mesocolon, is divided into left and right parts by the oblique attachment of the mesentery and contains the small intestine and the ascending and descending colon. The left infracolic compartment is continuous with the pelvic cavity.

The supracolic and infracolic compartments are connected by the paracolic gutters which lie between the posterolateral abdominal wall and the lateral aspect of the ascending or descending colon.

The omental bursa (lesser sac) is a smaller subdivision of the peritoneal cavity posterior to the stomach and liver and anterior to the pancreas, and is continuous with the greater sac through the epiploic foramen.

Omenta

The omenta are double layers of peritoneum that extends from the stomach and proximal part of the duodenum to other organs.

The greater omentum descends from the greater curvature of the stomach and first part of the duodenum, drapes inferiorly over the transverse colon and the coils of the jejunum and ileum, then folds back up posteriorly and ascends to become adherent to the peritoneum on the superior surface of the transverse colon and the anterior layer of the transverse mesocolon before arriving at the posterior abdominal wall.

The lesser omentum is considerably smaller and extends from the lesser curvature of the stomach and the first part of the duodenum to the inferior surface of the liver.

The greater omentum is often referred to as the 'policeman of the abdomen' because of its apparent ability to migrate to any inflamed area and wrap itself around the organ to wall off inflammation. The greater omentum is also an important site for metastatic tumour spread; direct omental spread by a transcoelomic route is common for carcinoma of the ovary.

Mesenteries

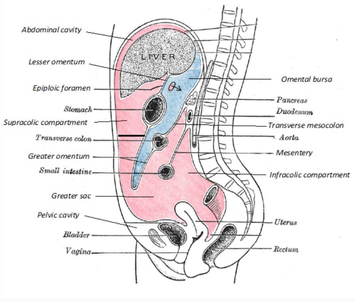
Mesenteries are peritoneal folds that attach viscera to the posterior abdominal wall. They allow some movement and provide a conduit for vessels, nerves and lymphatics to reach the viscera and include:

- the mesentery – associated with parts of the small intestine
- the transverse mesocolon – associated with transverse colon
- the sigmoid mesocolon – associated with the sigmoid colon.

The mesentery is a large, fan-shaped, double-layered fold of peritoneum that connects the jejunum and ileum to the posterior abdominal wall. Its superior attachment is at the duodenojejunal junction, just to the left of the upper lumbar part of the vertebral column. It passes obliquely downwards and to the right, ending at the ileocaecal junction near the upper border of the right sacroiliac joint.

The transverse mesocolon is a fold of peritoneum that connects the transverse colon to the posterior abdominal wall. It leaves the posterior abdominal wall across the anterior surface of the head and body of the pancreas and passes outwards to surround the transverse colon. Its anterior layer is adherent to the posterior layer of the greater omentum.

The sigmoid mesocolon is an inverted V-shaped peritoneal fold that attaches the sigmoid colon to the abdominal wall. The apex of the V is near the division of the left common iliac artery, with the left limb of the descending V along the medial border of the left psoas major muscle, and the right limb descending into the pelvis to end at the level of vertebra S3.



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Anatomy: Abdomen

Question 40 of 125



Which of the following lies immediately medial to the second part of the duodenum:

a Transverse colon

b Spleen

c Right kidney

d Head of the pancreas

e Stomach

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Anatomy: Abdomen

Question 40 of 125

Which of the following lies immediately medial to the second part of the duodenum:

a) Transverse colon ✗
b) Spleen
c) Right kidney
d) Head of the pancreas ✓
e) Stomach

Answer

The descending (second) part is just to the right of the midline, extending from the neck of the gallbladder to the lower border of vertebra L3 and lying lateral to the head of the pancreas. This part contains the major duodenal papilla which is the common entrance for the bile and pancreatic ducts.

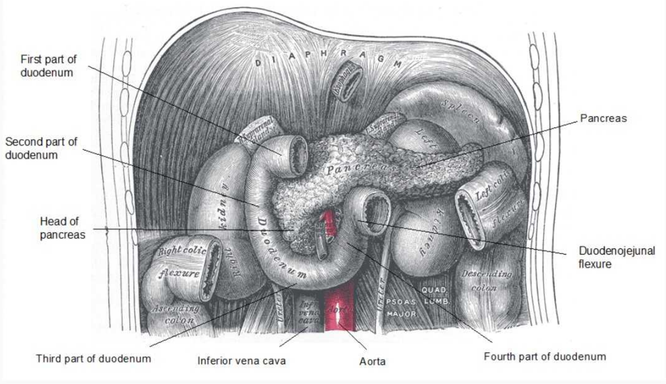
Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum. The first part of the small intestine is the duodenum.

The duodenum is a C-shaped structure, adjacent to the head of the pancreas, and above the level of the umbilicus. It is retroperitoneal except for its proximal part which is connected to the liver by the hepatoduodenal ligament of the lesser omentum.

Parts of the duodenum

- The superior (first) part extends from the pyloric orifice of the stomach to the neck of the gallbladder, lies just to the right of the body of vertebra L1, and passes anterior to the inferior vena cava and superior to the head of the pancreas.
- The descending (second) part is just to the right of the midline, extending from the neck of the gallbladder to the lower border of vertebra L3 and lying lateral to the head of the pancreas. This part contains the major duodenal papilla which is the common entrance for the bile and pancreatic ducts.
- The inferior (third) part is the longest section, crossing the inferior vena cava, the aorta and the vertebral column at the level of vertebra L3 and lying inferior to the pancreas.
- The ascending (fourth) part passes upwards on, or to the left of the aorta to approximately the upper border of vertebra L2 and terminates at the duodenojejunal flexure.



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Blood supply

The arterial supply of the duodenum is primarily from the pancreaticoduodenal arteries, branches of the superior mesenteric artery and the gastroduodenal artery (branch of the common hepatic artery from the coeliac trunk).

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Anatomy: Abdomen



Question 41 of 125

The gallbladder is located on which of the following aspects of the liver:

a Right lobe

b Left lobe

c Quadrate lobe

d Caudate lobe

e Diaphragmatic surface

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The gallbladder is located on which of the following aspects of the liver:

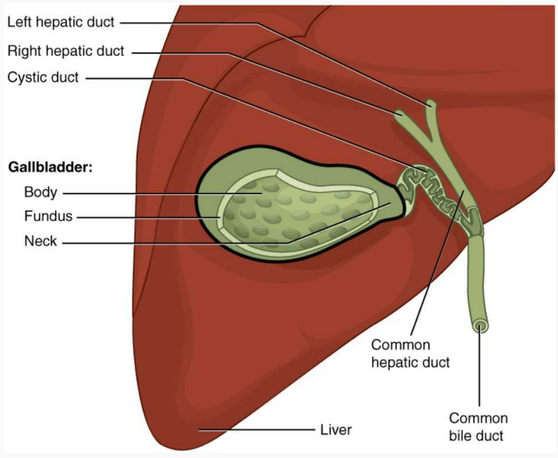
a) Right lobe ✔
b) Left lobe
c) Quadrate lobe
d) Caudate lobe
e) Diaphragmatic surface

Answer

The gallbladder is a pear-shaped sac lying on the visceral surface of the right lobe of the liver in a fossa between the right and quadrate lobes.

Notes

The gallbladder is a pear-shaped sac lying on the visceral surface of the right lobe of the liver in a fossa between the right and quadrate lobes. It is an intraperitoneal structure and lies in the right hypochondrium. It is located at the junction of the right ninth costal cartilage and the lateral border of the rectus abdominis muscle which is the site of maximal tenderness in the acute inflammation of the gallbladder.



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Structure

It has:

- a rounded end, the fundus, which may project from the inferior border of the liver
- a major part in the fossa, the body, which may lie against the transverse colon and the superior part of the duodenum
- and a narrow part, the neck, which tapers to become continuous with the cystic duct.

The neck contains a mucosal fold, known as Hartmann's pouch, which is a common site for gallstones to become lodged.

Relations

The gallbladder lies:

- posterior and inferior to the liver
- posterior to the anterior abdominal wall
- anterior to the transverse colon and the proximal duodenum
- superior to the biliary tree and the duodenum.

Innervation

Inflammation of the gallbladder may present with pain in the right upper quadrant and also the right shoulder; this is due to irritation of the diaphragmatic visceral peritoneum innervated by the phrenic nerve (C3 – C5) that also innervate skin over the shoulder.

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Anatomy: Abdomen

Question 42 of 125



The sigmoid colon extends as low as which of the following vertebral levels:

a L4

b L5

c S1

d S2

e S3

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The sigmoid colon extends as low as which of the following vertebral levels:

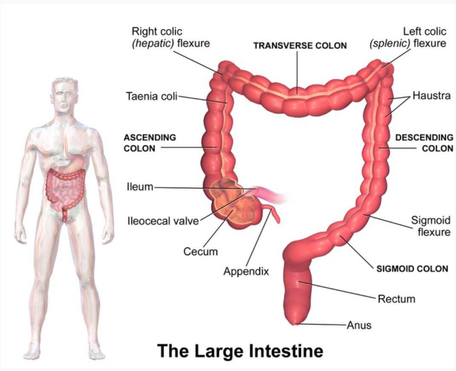
a) L4 ✗
b) L5
c) S1
d) S2
e) S3 ✓

Answer

The colon enters the upper part of the pelvis as the sigmoid colon, which begins above the pelvic inlet and extends to the level of vertebra S3 where it is continuous with the rectum.

Notes

The large intestine extends from the distal end of the ileum to the anus, and comprises the caecum, appendix, colon, rectum and anal canal.



Blausen.com staff. "Blausen gallery 2014". Wikiversity Journal of Medicine. DOI:10.15347/wjm/2014.010. ISSN 20018762. (Own work) [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons

Colon

The colon continues from the caecum in the right groin as the ascending colon, which passes upwards through the right flank and into the right hypochondrium.

Just below the right lobe of the liver, it bends to the left forming the right colic flexure (hepatic flexure), and crosses the abdomen as the transverse colon to the left hypochondrium. The transverse colon is related superiorly to the liver, gallbladder, greater curvature of the stomach and the lateral end of the spleen.

At this point, just below the spleen, it bends downwards forming the left colic flexure (splenic flexure) and continues as the descending colon through the left flank and into the left groin. The splenic flexure is higher and more posterior than the hepatic flexure, and is attached to the diaphragm by the phrenicocolic ligament.

The colon enters the upper part of the pelvis as the sigmoid colon, which begins above the pelvic inlet and extends to the level of vertebra S3 where it is continuous with the rectum. This S-shaped structure is quite mobile except at its proximal and distal end which are attached to the descending colon and rectum respectively. Between these points, it is suspended by the sigmoid mesocolon.

The ascending and descending segments are retroperitoneal and the transverse and sigmoid segments are intraperitoneal.

Relations

Colon	Anterior relations	Posterior relations
Ascending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, right kidney
Transverse colon	Liver, gallbladder, stomach, greater omentum, anterior abdominal wall	Second part of duodenum, head of pancreas, upper end of mesentery, duodenojejunal flexure, coils of jejunum and ileum
Descending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, left kidney
Sigmoid colon	Bladder, uterus and upper vagina	Rectum, sacrum, ileum

Blood supply

The arterial supply to the colon is derived from the superior mesenteric artery (caecum, appendix, ascending colon, hepatic flexure, proximal two-thirds of transverse colon) and the inferior mesenteric artery (distal one-thirds of transverse colon, splenic flexure, descending colon, sigmoid colon).

As the terminal vessels of the superior mesenteric and inferior mesenteric artery approach the colon they split into many colic branches which anastomose with each other. These anastomoses from a continuous arterial channel which extends the length of the colon, the marginal artery.

At the junctional area of the supply of the superior and inferior mesenteric arteries, the anastomosis may not be sufficient, thus the splenic flexure is most susceptible to ischaemia.

Innervation

The visceral pain sensation from the ascending and transverse colon travels through the lesser splanchnic nerve to the T10 – T11 spinal cord segments hence pain is referred to the umbilical and hypogastric regions.

Pain from the descending and sigmoid colon is carried in the lumbar splanchnic nerves to the L1 and L2 spinal cord segments hence pain is referred to the inguinal region and thigh.

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Anatomy: Abdomen



Question 43 of 125

A 65 year old man presents to ED complaining of abdominal pain and weight loss. Imaging shows a tumour anterior to the inferior vena cava, Which of the following structures is most likely to be compressed by this tumour:

a Cisterna chyli

b Third part of the duodenum

c Right kidney

d Ascending colon

e Right sympathetic trunk

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Anatomy: Abdomen

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a) Cisterna chyli ✗
b) Third part of the duodenum ✓
c) Right kidney
d) Ascending colon
e) Right sympathetic trunk

Answer

The third part of the duodenum crosses anterior to the inferior vena cava. The other structures do not cross the IVC anteriorly.

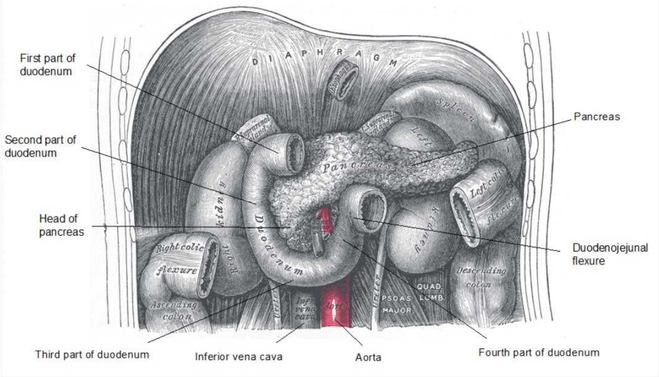
Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum. The first part of the small intestine is the duodenum.

The duodenum is a C-shaped structure, adjacent to the head of the pancreas, and above the level of the umbilicus. It is retroperitoneal except for its proximal part which is connected to the liver by the hepatoduodenal ligament of the lesser omentum.

Parts of the duodenum

- The superior (first) part extends from the pyloric orifice of the stomach to the neck of the gallbladder, lies just to the right of the body of vertebra L1, and passes anterior to the inferior vena cava and superior to the head of the pancreas.
- The descending (second) part is just to the right of the midline, extending from the neck of the gallbladder to the lower border of vertebra L3 and lying lateral to the head of the pancreas. This part contains the major duodenal papilla which is the common entrance for the bile and pancreatic ducts.
- The inferior (third) part is the longest section, crossing the inferior vena cava, the aorta and the vertebral column at the level of vertebra L3 and lying inferior to the pancreas.
- The ascending (fourth) part passes upwards on, or to the left of the aorta to approximately the upper border of vertebra L2 and terminates at the duodenojejunal flexure.



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Blood supply

The arterial supply of the duodenum is primarily from the pancreaticoduodenal arteries, branches of the superior mesenteric artery and the gastroduodenal artery (branch of the common hepatic artery from the coeliac trunk).

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Which of the following structures is NOT retroperitoneal:

a Rectum

b Inferior vena cava

c Ureters

d Tail of pancreas

e Kidneys

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Which of the following structures is NOT retroperitoneal:

a) Rectum ✖
b) Inferior vena cava
c) Ureters
d) Tail of pancreas ✔
e) Kidneys

Answer

The tail of the pancreas is intraperitoneal.

Notes

The peritoneum is a continuous double-layered serous membrane.

The parietal peritoneum lines the walls of the abdominal cavity and the visceral peritoneum lines the viscera.

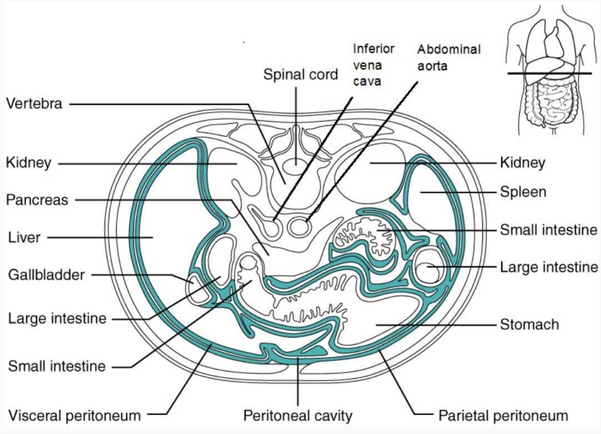
Between the parietal and visceral layers of peritoneum is a potential space, the peritoneal cavity.

Abdominal viscera are either suspended in the peritoneal cavity by folds of peritoneum called mesenteries (intraperitoneal viscera) or are outside the peritoneal cavity bound to the posterior abdominal wall (retroperitoneal viscera). Retroperitoneal organs are only covered in peritoneum on their anterior surface.

Innervation

The parietal peritoneum associated with the abdominal wall is innervated by somatic afferents carried in branches of the associated spinal nerves and is therefore sensitive to pressure, pain and temperature, and gives rise to well-localised pain. The diaphragmatic peritoneum is supplied by the phrenic nerve (C3 – C5) and the remainder of the parietal peritoneum is supplied segmentally by intercostal and lumbar nerves.

The visceral peritoneum is innervated by visceral afferents that accompany autonomic nerves back to the CNS and therefore activation gives rise to referred and poorly localised sensations of discomfort and to visceral motor activity.



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Retroperitoneal viscera

A useful mnemonic to help remember which abdominal organs are retroperitoneal is SAD PUCKER:

- Suprarenal glands
- Aorta and Inferior vena cava
- Duodenum (2nd and 3rd parts)
- Pancreas (except for the tail)
- Ureters (proximal) and Bladder
- Colon (ascending and descending)
- Kidneys
- (O)esophagus
- Rectum (lower two-thirds)

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Anatomy: Abdomen



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The gallbladder occupies which of the following regions of the abdomen:

a Left hypochondrium

b Right hypochondrium

c Right hypochondrium and right flank

d Right hypochondrium and epigastric region

e Epigastric region and umbilicus

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The gallbladder occupies which of the following regions of the abdomen:

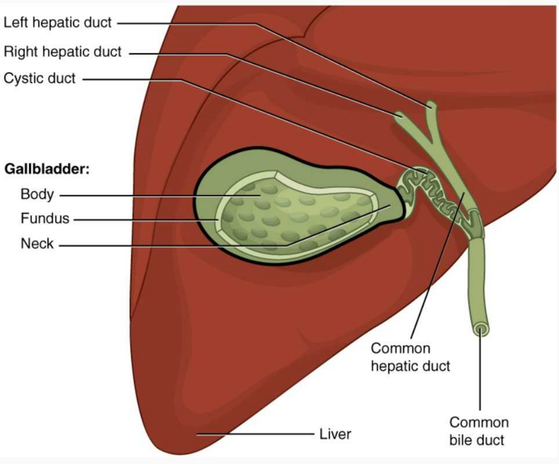
a) Left hypochondrium ✗
b) Right hypochondrium ✓
c) Right hypochondrium and right flank
d) Right hypochondrium and epigastric region
e) Epigastric region and umbilicus

Answer

The gallbladder lies in the right hypochondrium.

Notes

The gallbladder is a pear-shaped sac lying on the visceral surface of the right lobe of the liver in a fossa between the right and quadrate lobes. It is an intraperitoneal structure and lies in the right hypochondrium. It is located at the junction of the right ninth costal cartilage and the lateral border of the rectus abdominis muscle which is the site of maximal tenderness in the acute inflammation of the gallbladder.



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Structure

It has:

- a rounded end, the fundus, which may project from the inferior border of the liver
- a major part in the fossa, the body, which may lie against the transverse colon and the superior part of the duodenum
- and a narrow part, the neck, which tapers to become continuous with the cystic duct.

The neck contains a mucosal fold, known as Hartmann's pouch, which is a common site for gallstones to become lodged.

Relations

The gallbladder lies:

- posterior and inferior to the liver
- posterior to the anterior abdominal wall
- anterior to the transverse colon and the proximal duodenum
- superior to the biliary tree and the duodenum.

Innervation

Inflammation of the gallbladder may present with pain in the right upper quadrant and also the right shoulder; this is due to irritation of the diaphragmatic visceral peritoneum innervated by the phrenic nerve (C3 – C5) that also innervate skin over the shoulder.

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Anatomy: Abdomen



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A 79 year old patient, with a history of AF, presents to ED complaining of sudden onset severe abdominal pain. Imaging shows occlusion of the superior mesenteric artery. Which of the following structures is most likely affected:

a Stomach

b First part of the duodenum

c Jejunum and ileum

d Splenic flexure

e Rectum

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Anatomy: Abdomen

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A 79 year old patient, with a history of AF, presents to ED complaining of sudden onset severe abdominal pain. Imaging shows occlusion of the superior mesenteric artery. Which of the following structures is most likely affected:

a) Stomach ✖
b) First part of the duodenum
c) Jejunum and ileum ✔
d) Splenic flexure
e) Rectum

Answer

The superior mesenteric artery supplies midgut structures including the duodenum (after the major duodenal papilla in the second part), the jejunum, the ileum, the caecum and appendix, the ascending colon and the proximal two-thirds of the transverse colon. Occlusion of the superior mesenteric artery restricts blood flow to these structures resulting in intestinal ischaemia.

Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum.

The jejunum and ileum make up the last two sections of the small intestine.

The jejunum and ileum are intraperitoneal, attached to the posterior abdominal wall by the mesentery.

Jejunum

The jejunum represents the proximal two-fifths. It is mostly in the left upper quadrant of the abdomen and is larger in diameter and has a thicker wall than the ileum.

Ileum

The ileum makes up the distal three-fifths and is mostly in the right lower quadrant. The ileum invaginates into the large intestine at the ileocaecal junction forming the ileocaecal valve, which prevents reflux from the caecum to the ileum and regulates the passage of contents from the ileum to the caecum.

Blood supply

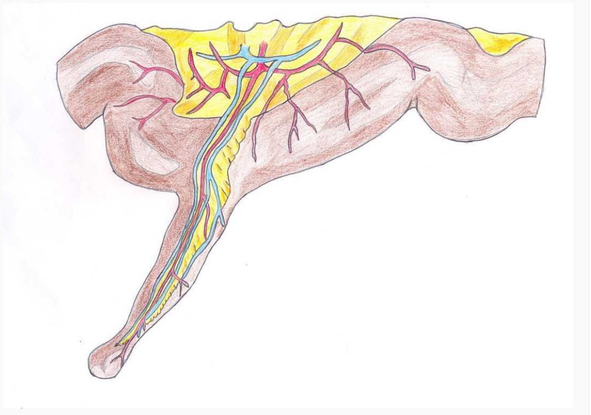
The arterial supply to the jejunum and ileum is derived from the superior mesenteric artery.

Innervation

The sympathetic nerve supply is derived from the T9 – T10 spinal cord segments. Pain from the small jejunum and ileum is referred to the peri-umbilical region.

Meckel's diverticulum

A Meckel's diverticulum is the remnant of the proximal part of the yolk stalk (vitelline duct) that extends into the umbilical cord in the embryo and lies on the antimesenteric border of the ileum, approximately **2 feet** proximal to the ileocaecal junction. It appears as a blind-ended tubular outpouching of bowel, about **2 inches** long, occurring in about **2%** of the population, and may contain **two types** of ectopic tissue (gastric and pancreatic). Complications include haemorrhage, intussusception, diverticulitis, ulceration and obstruction, and symptoms may mimic those of acute appendicitis.



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Anatomy: Abdomen



Question 47 of 125

A 24 year old man presents to ED complaining of severe sharp abdominal pain in his right iliac fossa. Which of the following most accurately describes the mechanism of the distribution of pain in this patient:

a Contact of inflamed appendix with visceral peritoneum stimulates visceral afferents

b Contact of inflamed appendix with visceral peritoneum stimulates somatic afferents

c The appendix is a midgut structure hence pain is referred to the T10 and T11 dermatomes

d Visceral afferents from the appendix travel with sympathetic nerves to the same spinal cord levels

e Contact of inflamed appendix with parietal peritoneum stimulates somatic afferents

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Anatomy: Abdomen

Question 47 of 125

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a) ✖
Contact of inflamed appendix with visceral peritoneum stimulates visceral afferents
b) Contact of inflamed appendix with visceral peritoneum stimulates somatic afferents
c) The appendix is a midgut structure hence pain is referred to the T10 and T11 dermatomes
d) Visceral afferents from the appendix travel with sympathetic nerves to the same spinal cord levels
e) Contact of inflamed appendix with parietal peritoneum stimulates somatic afferents ✔

Answer

Visceral afferents from the appendix, stimulated by the inflamed appendix, travel with the sympathetic nervous system to spinal cord level T10, therefore the patient will initially experience a visceral pain at the umbilicus. Irritation of the parietal peritoneum stimulates somatic afferents that innervate the body wall resulting in a sharp, localised pain in the RIF.

Notes

The peritoneum is a continuous double-layered serous membrane.

The parietal peritoneum lines the walls of the abdominal cavity and the visceral peritoneum lines the viscera.

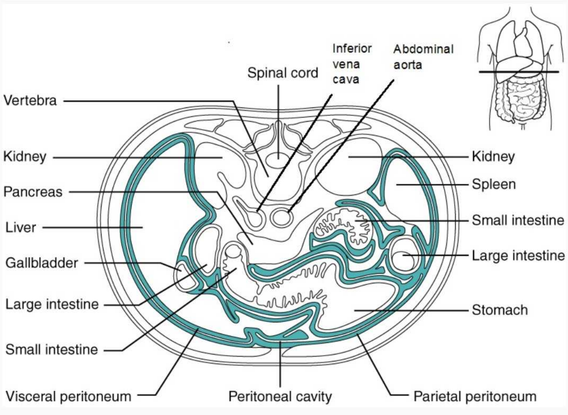
Between the parietal and visceral layers of peritoneum is a potential space, the peritoneal cavity.

Abdominal viscera are either suspended in the peritoneal cavity by folds of peritoneum called mesenteries (intraperitoneal viscera) or are outside the peritoneal cavity bound to the posterior abdominal wall (retroperitoneal viscera). Retroperitoneal organs are only covered in peritoneum on their anterior surface.

Innervation

The parietal peritoneum associated with the abdominal wall is innervated by somatic afferents carried in branches of the associated spinal nerves and is therefore sensitive to pressure, pain and temperature, and gives rise to well-localised pain. The diaphragmatic peritoneum is supplied by the phrenic nerve (C3 – C5) and the remainder of the parietal peritoneum is supplied segmentally by intercostal and lumbar nerves.

The visceral peritoneum is innervated by visceral afferents that accompany autonomic nerves back to the CNS and therefore activation gives rise to referred and poorly localised sensations of discomfort and to visceral motor activity.



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Retroperitoneal viscera

A useful mnemonic to help remember which abdominal organs are retroperitoneal is SAD PUCKER:

- Suprarenal glands
- Aorta and Inferior vena cava
- Duodenum (2nd and 3rd parts)
- Pancreas (except for the tail)
- Ureters (proximal) and Bladder
- Colon (ascending and descending)
- Kidneys
- (O)esophagus
- Rectum (lower two-thirds)

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Anatomy: Abdomen



Question 48 of 125

The inferior vena cava lies posterior to which of the following parts of the duodenum:

a Second part

b Third and fourth parts

c First and third parts

d First and second parts

e Second and third parts

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The inferior vena cava lies posterior to which of the following parts of the duodenum:

a) Second part ✗
b) Third and fourth parts
c) First and third parts ✓
d) First and second parts
e) Second and third parts

Answer

The superior (first) part extends from the pyloric orifice of the stomach to the neck of the gallbladder, lies just to the right of the body of vertebra L1, and passes anterior to the inferior vena cava and superior to the head of the pancreas. The inferior (third) part is the longest section, crossing the inferior vena cava, the aorta and the vertebral column at the level of vertebra L3 and lying inferior to the pancreas.

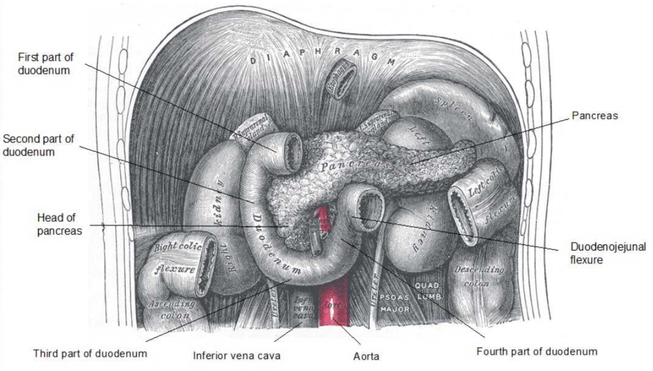
Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum. The first part of the small intestine is the duodenum.

The duodenum is a C-shaped structure, adjacent to the head of the pancreas, and above the level of the umbilicus. It is retroperitoneal except for its proximal part which is connected to the liver by the hepatoduodenal ligament of the lesser omentum.

Parts of the duodenum

- The superior (first) part extends from the pyloric orifice of the stomach to the neck of the gallbladder, lies just to the right of the body of vertebra L1, and passes anterior to the inferior vena cava and superior to the head of the pancreas.
- The descending (second) part is just to the right of the midline, extending from the neck of the gallbladder to the lower border of vertebra L3 and lying lateral to the head of the pancreas. This part contains the major duodenal papilla which is the common entrance for the bile and pancreatic ducts.
- The inferior (third) part is the longest section, crossing the inferior vena cava, the aorta and the vertebral column at the level of vertebra L3 and lying inferior to the pancreas.
- The ascending (fourth) part passes upwards on, or to the left of the aorta to approximately the upper border of vertebra L2 and terminates at the duodenojejunal flexure.



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Blood supply

The arterial supply of the duodenum is primarily from the pancreaticoduodenal arteries, branches of the superior mesenteric artery and the gastroduodenal artery (branch of the common hepatic artery from the coeliac trunk).

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Anatomy: Abdomen



Question 49 of 125

A 54 year old man presents to ED complaining of abdominal pain radiating to his back. Imaging shows a tumour at the neck of the pancreas. Which of the following structures would first receive metastatic cells from this tumour:

a Spleen

b Stomach

c Duodenum

d Liver

e Spine

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Question 49 of 125

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b) Stomach
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d) Liver ✔
e) Spine

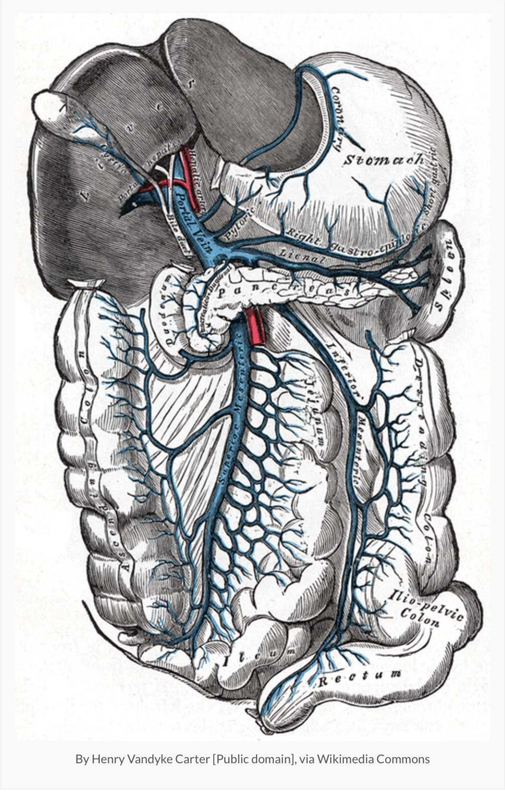
Answer

The liver would be the first structure to receive metastatic cells because they would flow through the portal venous system from the pancreas to the liver.

Notes

The portal vein is the final common pathway for the transport of venous blood from the spleen, pancreas, gallbladder and abdominal part of the gastrointestinal tract.

It is formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2.



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Portosystemic anastomoses

The hepatic portal system drains deoxygenated nutrient-rich blood from the visceral organs of the abdomen to the liver. Normally 100% of portal venous blood flow is recovered from the hepatic veins. In patients with elevated portal vein pressure e.g. from cirrhosis, there is significantly less blood flow to the liver and the rest of the blood enters collateral channels which drain into the systemic circulation at specific points.

Portosystemic anastomoses occur at certain specific points, the largest of these being:

- The gastroesophageal junction around the cardia of the stomach where the left gastric vein and its tributaries from a portosystemic anastomosis with tributaries to the azygos system of veins of the caval system
- The anus where the superior rectal vein of the portal system anastomoses with the middle and inferior rectal veins of the systemic venous system
- The anterior abdominal wall around the umbilicus where the portal paraumbilical veins anastomose with systemic veins on the anterior abdominal wall

When pressure in the portal vein is elevated, venous enlargement (varices) tends to occur at and around these sites producing:

- oesophageal varices at the gastroesophageal junction
- varices at the anorectal junction
- caput medusae at the umbilicus

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Anatomy: Abdomen



Question 50 of 125

A 64 year old man with known liver cirrhosis secondary to chronic alcohol abuse presents to ED vomiting profuse bright red blood. Endoscopy demonstrates ruptured oesophageal varices. Which of the following veins forms a portosystemic anastomosis with caval veins to form the varices:

a Right gastric vein

b Splenic vein

c Left gastric vein

d Left hepatic vein

e Left gastro-omental vein

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c) Left gastric vein ✔
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e) Left gastro-omental vein

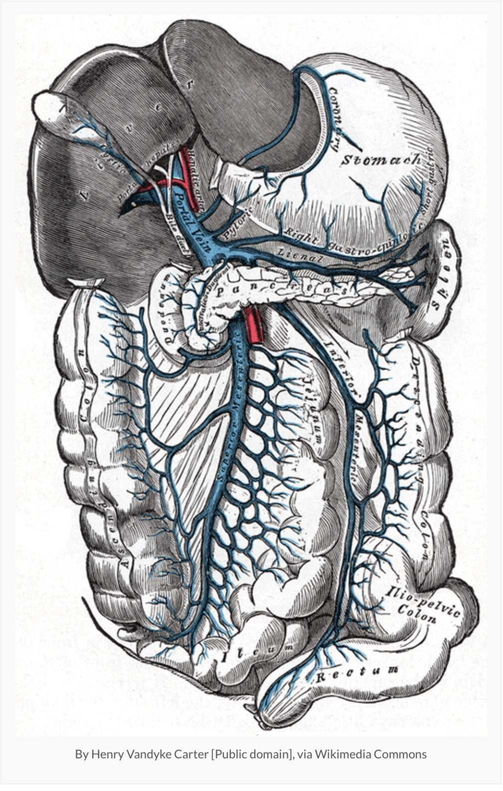
Answer

The left gastric vein and its tributaries from a portosystemic anastomosis with tributaries to the azygos system of veins of the caval system at the gastroesophageal junction around the cardia of the stomach.

Notes

The portal vein is the final common pathway for the transport of venous blood from the spleen, pancreas, gallbladder and abdominal part of the gastrointestinal tract.

It is formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2.



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Anatomy: Abdomen



Question 51 of 125

The spleen occupies which of the following abdominal regions:

a Right hypochondrium

b Left hypochondrium

c Epigastrium

d Left hypochondrium and epigastrium

e Left hypochondrium and left flank

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The spleen occupies which of the following abdominal regions:

a) **Right hypochondrium** ✗
b) Left hypochondrium ✓
c) Epigastrium
d) Left hypochondrium and epigastrium
e) Left hypochondrium and left flank

Answer

The spleen lies in the left hypochondrium of the abdomen.

Notes

The intraperitoneal spleen lies against the diaphragm, in the area of rib 9 – 11. It lies in the left hypochondrium of the abdomen. The spleen cannot normally be palpated on clinical examination.

The spleen is an organ of the reticuloendothelial system and acts:

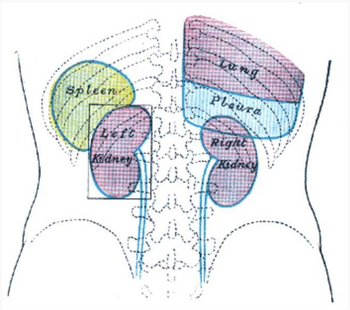
- to filter blood to remove old and defective blood cells
- as a blood reservoir
- to produce white blood cells
- to produce an immune response

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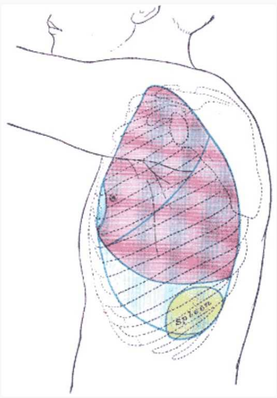
The spleen lies posterior to the stomach, superior to the left colic flexure and laterally to the left kidney and tail of the pancreas.

Surface markings

The spleen projects onto the left side and back in the area of ribs 9 – 11. The spleen follows the contour of rib 10 and extends from the superior pole of the left kidney to just posterior to the midaxillary line.



By Henry Vandyke Carter [Public domain], via Wikimedia Commons



By Henry Vandyke Carter [Public domain], via Wikimedia Commons

Splenic rupture

This most commonly occurs due to localised trauma to the left upper quadrant. It may be associated with left lower rib fractures. Because the spleen has an extremely thin capsule it is susceptible to injury even when there is no damage to surrounding structures and because the spleen is highly vascular, when ruptured, it bleeds profusely into the peritoneal cavity.

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Anatomy: Abdomen



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A 65 year old woman presents to ED complaining of fever, right upper quadrant pain, and jaundice. Imaging shows an obstructing gallstone. Which of the following structures is most likely obstructed by the gallstone:

a Pancreatic duct

b Cystic duct

c Left hepatic duct

d Common bile duct

e Right hepatic duct

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A 65 year old woman presents to ED complaining of fever, right upper quadrant pain, and jaundice. Imaging shows an obstructing gallstone. Which of the following structures is most likely obstructed by the gallstone:

a) **Pancreatic duct** ✗
b) Cystic duct
c) Left hepatic duct
d) Common bile duct ✓
e) Right hepatic duct

Answer

Jaundice results from obstruction to the outflow of bile. Obstruction of the common bile duct allows no collateral pathway for the drainage of bile from the liver or gallbladder. The cystic duct would block outflow from the gallbladder but allow for bile flow from the liver. Obstruction of either the right or left hepatic duct would still allow outflow from the liver and gallbladder. The pancreatic duct is not involved in the path of bile flow from the liver to the duodenum.

Notes

Biliary tree

The biliary tree begins in the liver parenchyma with the formation of the left and right hepatic duct which drain bile from the liver where it has been synthesised. These two ducts meet to form the common hepatic duct which runs near the liver, with the hepatic artery proper and portal vein in the free margin of the lesser omentum.

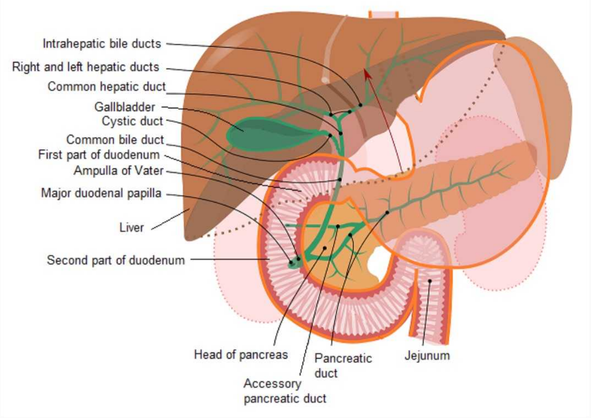
As the common hepatic duct descends, it is joined by the cystic duct, which is a continuation of the neck of the gallbladder. The common hepatic duct and the cystic duct combine to form the common bile duct. At this point the bile duct lies to the right of the hepatic artery proper and usually to the right of, and anterior to, the portal vein in the free margin of the lesser omentum.

As the common bile duct descends, it passes posterior to the first part of the duodenum before joining with the pancreatic duct from the pancreas, forming the hepatopancreatic ampulla (ampulla of Vater) at the major duodenal papilla, located in the second part of the duodenum. Surrounding the ampulla is the sphincter of Oddi, a collection of smooth muscle which can open to allow bile and pancreatic fluid to empty into the duodenum.

Common bile duct relations

The common bile duct can be divided into three main regions, based on its relation to the duodenum:

- The first supraduodenal region is the upper one-third which lies in the free margin of the lesser omentum with the hepatic artery and portal vein. The common bile duct lies anterior to the portal vein and to the right of the hepatic artery proper.
- The second retroduodenal region is the middle one-third which lies posterior to the first part of the duodenum. The gastroduodenal artery lies on its left aspect and the portal vein on its posterior aspect.
- The third infraduodenal region is the lower one-third which lies in a groove on the posterior surface of the head of the pancreas, to the left of the second part of the duodenum and anterior to the right renal vein and inferior vena cava.



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Anatomy: Abdomen



Question 53 of 125

A 26 year old woman is brought to ED following a road traffic accident. Focussed assessment for sonography in trauma (FAST) on the supine patient demonstrates free intraperitoneal fluid. Which of the following spaces is most likely to be affected:

a Hepatorenal recess

b Vesicouterine recess

c Rectouterine recess

d Subhepatic recess

e Subphrenic recess

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Question 53 of 125

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a) **Hepatorenal recess** ✔
b) Vesicouterine recess
c) Rectouterine recess
d) Subhepatic recess
e) Subphrenic recess

Answer

In a supine patient, fluid accumulation will occur most often in the hepatorenal pouch (of Morrison), which is the lowest space in the peritoneal cavity in the supine position, located behind the liver and anterior to the right kidney. The vesicouterine (between the bladder and the uterus) and rectouterine (between the uterus and the rectum) spaces are also potential spaces for fluid accumulation, however fluid accumulation occurs in the erect position.

Notes

Structure	Key anatomy
Peritoneal cavity	Divided into greater and lesser sacs
Greater sac	Divided into supracolic and infracolic compartments by transverse mesocolon, compartments connected by paracolic gutters
Supracolic compartment	Contains stomach, liver and spleen, lies under cover of costal limits of thoracic cage
Infracolic compartment	Divided into left and right parts by oblique attachment of mesentery, contains small intestine and ascending/descending colon, continuous with pelvic cavity
Lesser sac (omental bursa	Lies posterior to stomach and liver and anterior to pancreas, continuous with greater sac through epiploic foramen
Greater omentum	Descends from greater curvature of stomach and first part of duodenum, drapes inferiorly over transverse colon, jejunum and ileum, folds back up and ascends to adhere to transverse colon/mesocolon before arriving at posterior abdominal wall
Lesser omentum	Extends from lesser curvature of stomach and first part of duodenum to inferior surface of liver
Mesentery	Connects jejunum and ileus to posterior abdominal wall, attaches superiorly to duodenojejunal junction and passes oblique downwards and to the right to end at ileocecal junction
Transverse mesocolon	Connects transverse colon to posterior abdominal wall, leaves posterior abdominal wall across anterior surface of head and body of pancreas and passes outwards to surround transverse colon
Sigmoid mesocolon	Connects sigmoid colon to abdominal wall, V-shaped fold with apex near division of left common iliac artery, left limb descending along medial border of left psoas major muscle and right limb descending into pelvis to end at vertebral level S3

Compartments of the peritoneal cavity

The peritoneal cavity is divided into the greater sac and the omental bursa (lesser sac).

The greater sac accounts for most of the space in the peritoneal cavity, beginning superiorly at the diaphragm and continuing inferiorly in the pelvic cavity. It is further divided into two compartments by the transverse mesocolon:

- The supracolic compartment lies above the transverse mesocolon and contains the stomach, liver and spleen. It lies largely under cover of the costal limits of the thoracic cage.
- The infracolic compartment lies below the transverse mesocolon, is divided into left and right parts by the oblique attachment of the mesentery and contains the small intestine and the ascending and descending colon. The left infracolic compartment is continuous with the pelvic cavity.

The supracolic and infracolic compartments are connected by the paracolic gutters which lie between the posterolateral abdominal wall and the lateral aspect of the ascending or descending colon.

The omental bursa (lesser sac) is a smaller subdivision of the peritoneal cavity posterior to the stomach and liver and anterior to the pancreas, and is continuous with the greater sac through the epiploic foramen.

Omenta

The omenta are double layers of peritoneum that extends from the stomach and proximal part of the duodenum to other organs.

The greater omentum descends from the greater curvature of the stomach and first part of the duodenum, drapes inferiorly over the transverse colon and the coils of the jejunum and ileum, then folds back up posteriorly and ascends to become adherent to the peritoneum on the superior surface of the transverse colon and the anterior layer of the transverse mesocolon before arriving at the posterior abdominal wall.

The lesser omentum is considerably smaller and extends from the lesser curvature of the stomach and the first part of the duodenum to the inferior surface of the liver.

The greater omentum is often referred to as the 'policeman of the abdomen' because of its apparent ability to migrate to any inflamed area and wrap itself around the organ to wall off inflammation. The greater omentum is also an important site for metastatic tumour spread; direct omental spread by a transcoelomic route is common for carcinoma of the ovary.

Mesenteries

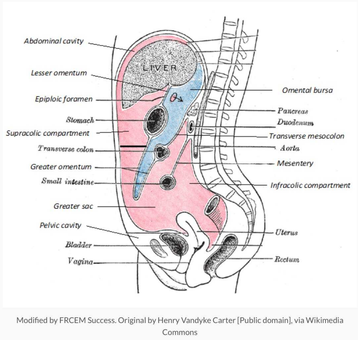
Mesenteries are peritoneal folds that attach viscera to the posterior abdominal wall. They allow some movement and provide a conduit for vessels, nerves and lymphatics to reach the viscera and include:

- the mesentery – associated with parts of the small intestine
- the transverse mesocolon – associated with transverse colon
- the sigmoid mesocolon – associated with the sigmoid colon.

The mesentery is a large, fan-shaped, double-layered fold of peritoneum that connects the jejunum and ileum to the posterior abdominal wall. Its superior attachment is at the duodenojejunal junction, just to the left of the upper lumbar part of the vertebral column. It passes obliquely downwards and to the right, ending at the ileocaecal junction near the upper border of the right sacroiliac joint.

The transverse mesocolon is a fold of peritoneum that connects the transverse colon to the posterior abdominal wall. It leaves the posterior abdominal wall across the anterior surface of the head and body of the pancreas and passes outwards to surround the transverse colon. Its anterior layer is adherent to the posterior layer of the greater omentum.

The sigmoid mesocolon is an inverted V-shaped peritoneal fold that attaches the sigmoid colon to the abdominal wall. The apex of the V is near the division of the left common iliac artery, with the left limb of the descending V along the medial border of the left psoas major muscle, and the right limb descending into the pelvis to end at the level of vertebra S3.



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Anatomy: Abdomen



Question 54 of 125

The union of the common bile duct and the pancreatic duct forms which of the following:

a Cystic duct

b Hepatic duct

c Sphincter of Oddi

d Major papilla

e Ampulla of Vater

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Anatomy: Abdomen

Question 54 of 125

The union of the common bile duct and the pancreatic duct forms which of the following:

a) Cystic duct ✖
b) Hepatic duct
c) Sphincter of Oddi
d) Major papilla
e) Ampulla of Vater ✔

Answer

As the common bile duct descends, it passes posterior to the first part of the duodenum before joining with the pancreatic duct from the pancreas, forming the hepatopancreatic ampulla (ampulla of Vater) at the major duodenal papilla, located in the second part of the duodenum.

Notes

Biliary tree

The biliary tree begins in the liver parenchyma with the formation of the left and right hepatic duct which drain bile from the liver where it has been synthesised. These two ducts meet to form the common hepatic duct which runs near the liver, with the hepatic artery proper and portal vein in the free margin of the lesser omentum.

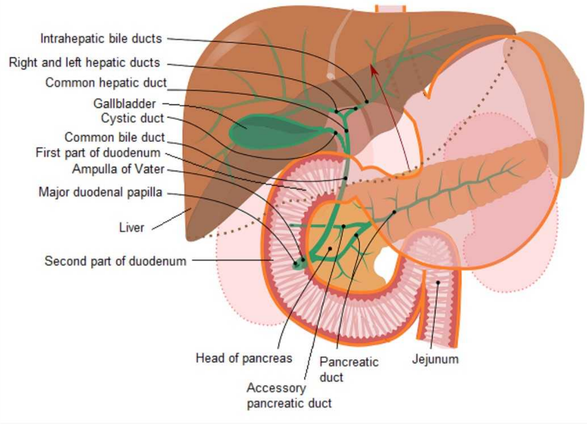
As the common hepatic duct descends, it is joined by the cystic duct, which is a continuation of the neck of the gallbladder. The common hepatic duct and the cystic duct combine to form the common bile duct. At this point the bile duct lies to the right of the hepatic artery proper and usually to the right of, and anterior to, the portal vein in the free margin of the lesser omentum.

As the common bile duct descends, it passes posterior to the first part of the duodenum before joining with the pancreatic duct from the pancreas, forming the hepatopancreatic ampulla (ampulla of Vater) at the major duodenal papilla, located in the second part of the duodenum. Surrounding the ampulla is the sphincter of Oddi, a collection of smooth muscle which can open to allow bile and pancreatic fluid to empty into the duodenum.

Common bile duct relations

The common bile duct can be divided into three main regions, based on its relation to the duodenum:

- The first supraduodenal region is the upper one-third which lies in the free margin of the lesser omentum with the hepatic artery and portal vein. The common bile duct lies anterior to the portal vein and to the right of the hepatic artery proper.
- The second retroduodenal region is the middle one-third which lies posterior to the first part of the duodenum. The gastroduodenal artery lies on its left aspect and the portal vein on its posterior aspect.
- The third infraduodenal region is the lower one-third which lies in a groove on the posterior surface of the head of the pancreas, to the left of the second part of the duodenum and anterior to the right renal vein and inferior vena cava.



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Anatomy: Abdomen



Question 55 of 125

The sympathetic nerve supply to the jejunum and ileum is derived from which of the following spinal cord segments:

a T3 – T4

b T6 – T10

c T9 – T10

d T10 – T12

e L1 – L2

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Anatomy: Abdomen

Question 55 of 125

The sympathetic nerve supply to the jejunum and ileum is derived from which of the following spinal cord segments:

a) T3 – T4 ✗
b) T6 – T10
c) T9 – T10 ✓
d) T10 – T12
e) L1 – L2

Answer

The sympathetic nerve supply is derived from the T9 – T10 spinal cord segments. Pain from the small jejunum and ileum is referred to the peri-umbilical region.

Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum.

The jejunum and ileum make up the last two sections of the small intestine.

The jejunum and ileum are intraperitoneal, attached to the posterior abdominal wall by the mesentery.

Jejunum

The jejunum represents the proximal two-fifths. It is mostly in the left upper quadrant of the abdomen and is larger in diameter and has a thicker wall than the ileum.

Ileum

The ileum makes up the distal three-fifths and is mostly in the right lower quadrant. The ileum invaginates into the large intestine at the ileocaecal junction forming the ileocaecal valve, which prevents reflux from the caecum to the ileum and regulates the passage of contents from the ileum to the caecum.

Blood supply

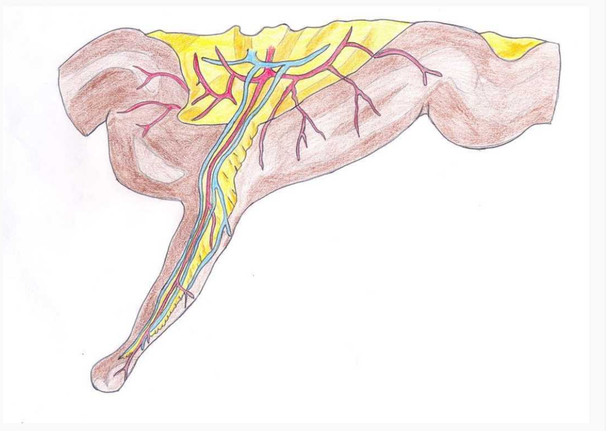
The arterial supply to the jejunum and ileum is derived from the superior mesenteric artery.

Innervation

The sympathetic nerve supply is derived from the T9 – T10 spinal cord segments. Pain from the small jejunum and ileum is referred to the peri-umbilical region.

Meckel's diverticulum

A Meckel's diverticulum is the remnant of the proximal part of the yolk stalk (vitelline duct) that extends into the umbilical cord in the embryo and lies on the antimesenteric border of the ileum, approximately **2 feet** proximal to the ileocaecal junction. It appears as a blind-ended tubular outpouching of bowel, about **2 inches** long, occurring in about **2%** of the population, and may contain **two types** of ectopic tissue (gastric and pancreatic). Complications include haemorrhage, intussusception, diverticulitis, ulceration and obstruction, and symptoms may mimic those of acute appendicitis.



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Anatomy: Abdomen



Question 56 of 125

The renal arteries arise from the abdominal aorta at which of the following vertebral levels:

a T11/T12

b T12/L1

c L1/L2

d L2/L3

e L3/L4

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Anatomy: Abdomen

Question 56 of 125

The renal arteries arise from the abdominal aorta at which of the following vertebral levels:

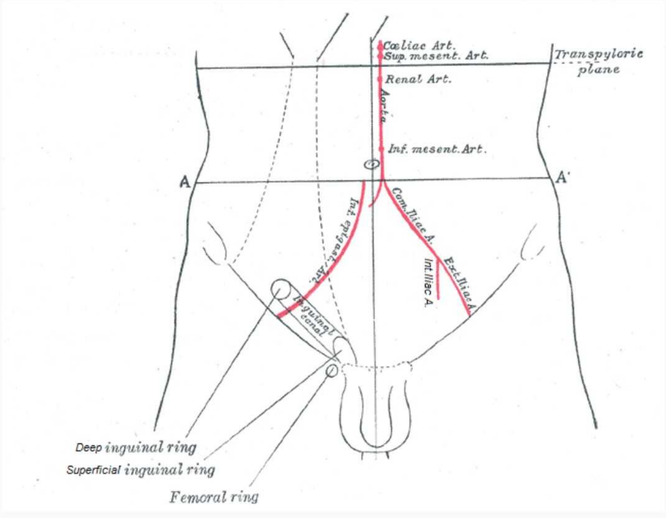
a) T11/T12 ✗
b) T12/L1
c) L1/L2 ✓
d) L2/L3
e) L3/L4

Answer

The renal arteries arise from the abdominal aorta at the level of vertebrae L1/L2.

Notes

The abdominal aorta begins at the aortic hiatus of the diaphragm, anterior to the lower border of vertebra T12. It descends through the abdomen, anterior to the vertebral bodies, and by the time it ends at the level of vertebra L4 it is slightly to the left of the midline. The main terminal branches of the abdominal aorta are the two common iliac arteries. This bifurcation can be visualised on the anterior abdominal wall as a point approximately 2.5 cm below the umbilicus.



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The abdominal aorta gives rise to:

- three anterior unpaired visceral branches
  - the coeliac trunk supplying the abdominal foregut (T12/L1 vertebral level)
  - the superior mesenteric artery supplying the abdominal midgut (L1 vertebral level)
  - the inferior mesenteric artery supplying the abdominal hindgut (L3 vertebral level)
- three lateral paired visceral branches
  - the middle suprarenal arteries
  - the renal arteries (L1/L2 vertebral level)
  - the gonadal arteries
- posterior parietal branches
  - the inferior phrenic arteries (paired)
  - the lumbar arteries (paired)
  - the median sacral artery (single)
- two terminal branches
  - left common iliac artery
  - right common iliac artery

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Anatomy: Abdomen



Question 57 of 125

The quadrate lobe of the liver lies between which of the following structures:

a Ligamentum teres and gallbladder

b Ligamentum venosum and gallbladder

c Ligamentum teres and inferior vena cava

d Ligamentum venosum and inferior vena cava

e Gallbladder and inferior vena cava

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Anatomy: Abdomen

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The quadrate lobe of the liver lies between which of the following structures:

a) Ligamentum teres and gallbladder ✔
b) Ligamentum venosum and gallbladder
c) Ligamentum teres and inferior vena cava
d) Ligamentum venosum and inferior vena cava
e) Gallbladder and inferior vena cava

Answer

The quadrate lobe is located between the gallbladder and the fissure for the ligamentum teres.

Notes

The liver is the largest visceral organ in the body and is primarily located in the right hypochondrium and epigastric region, extending into the left hypochondrium.

Surface marking

Most of the liver is under the right dome of the diaphragm and deep to the lower thoracic wall. The inferior margin of the liver can be palpated descending below the right costal margin on deep inspiration.

The inferior margin is indicated by a line that joins points at the right tenth costal cartilage in the midaxillary line, the tip of the right ninth costal cartilage, the transpyloric plane in the midline, the tip of the left eighth costal cartilage and the left fifth rib in the midclavicular line.

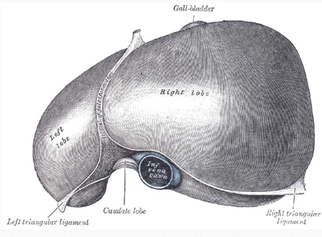
The superior margin is indicated by a line that joints a point on the left fifth rib at the midclavicular line to a corresponding point on the right side. The superior margin is concave in its central part and crosses behind the xiphisternal joint.

Anatomical surfaces

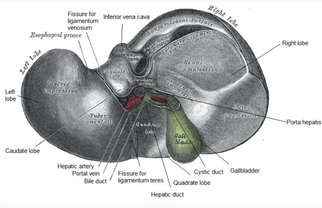
The liver has a diaphragmatic surface in the anterior, superior, and posterior directions and a visceral surface in the inferior direction.

The diaphragmatic surface of the liver is related anteriorly to the anterior abdominal wall and rib cage and superiorly to the diaphragm.

The visceral surface of the liver is related to the oesophagus, right anterior part of the stomach, superior part of the duodenum, lesser omentum, gallbladder, right colic flexure, right transverse colon, right kidney and right adrenal gland.



Diaphragmatic surface of liver. By Henry Vandyke Carter [Public domain], via Wikimedia Commons



Inferior surface of liver. Modified by FRCEM Success. Original by Henry Vandyke Carter [Public domain], via Wikimedia Commons

Lobes

There are four anatomical lobes to the liver.

- The liver is divided into the left and right lobe by the fossae for the gallbladder and the inferior vena cava.
- The caudate lobe sits between the fissure for the ligamentum venosum and the inferior vena cava.
- The quadrate lobe is located between the gallbladder and the fissure for the ligamentum teres.

The porta hepatis is the central intraperitoneal fissure of the liver that separates the caudate and the quadrate lobes. The porta hepatis serves as the point of entry into the liver for the hepatic arteries and portal vein, and the exit point for the hepatic ducts.

Liver lobules

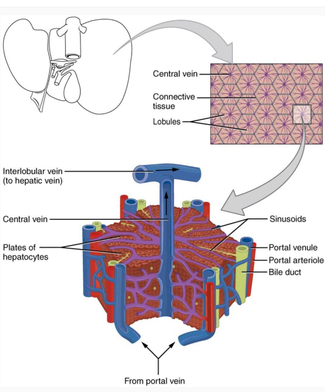
Microscopically, hepatocytes are arranged into lobules which are the functional units of the liver. Each lobule is hexagonal-shaped, and is drained by a venule in its centre, called a central vein (which drains to the hepatic vein).

At the periphery of the hexagon are three structures collectively known as the portal triad, comprising:

- a portal arteriole (a branch of the hepatic artery),
- a portal venule (a branch of the hepatic portal vein),
- a bile duct.

The portal triad also contains lymphatic vessels and vagal parasympathetic nerve fibres.

The liver sinusoids serve as a location for mixing of the oxygen-rich blood from the hepatic artery and the nutrient-rich blood from the portal vein.



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Blood supply

The liver has a unique dual blood supply. The arterial supply to the liver is from the left and right hepatic arteries derived from the hepatic artery proper, a branch of the common hepatic artery from the coeliac trunk.

The hepatic portal vein (formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2) supplies the liver with deoxygenated blood carrying nutrients absorbed from the small intestine.

Venous drainage of the liver is achieved through three hepatic veins, which return the venous blood to the inferior vena cava just inferior to the diaphragm.

Lymphatic drainage

The lymphatic vessels of the liver drain into hepatic lymph nodes which empty in the coeliac lymph nodes.

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Anatomy: Abdomen



Question 58 of 125

Hartmann's pouch is located where in the biliary system:

a Fundus of the gallbladder

b Body of the gallbladder

c Neck of the gallbladder

d Cystic duct

e Hepatopancreatic ampulla

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Anatomy: Abdomen

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Hartmann's pouch is located where in the biliary system:

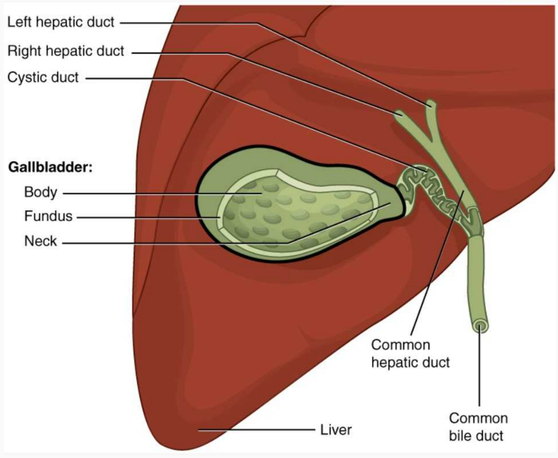
a) **Fundus of the gallbladder** ✗
b) Body of the gallbladder
c) Neck of the gallbladder ✓
d) Cystic duct
e) Hepatopancreatic ampulla

Answer

The neck of the gallbladder contains a mucosal fold, known as Hartmann's pouch, which is a common site for gallstones to become lodged.

Notes

The gallbladder is a pear-shaped sac lying on the visceral surface of the right lobe of the liver in a fossa between the right and quadrate lobes. It is an intraperitoneal structure and lies in the right hypochondrium. It is located at the junction of the right ninth costal cartilage and the lateral border of the rectus abdominis muscle which is the site of maximal tenderness in the acute inflammation of the gallbladder.



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Structure

It has:

- a rounded end, the fundus, which may project from the inferior border of the liver
- a major part in the fossa, the body, which may lie against the transverse colon and the superior part of the duodenum
- and a narrow part, the neck, which tapers to become continuous with the cystic duct.

The neck contains a mucosal fold, known as Hartmann's pouch, which is a common site for gallstones to become lodged.

Relations

The gallbladder lies:

- posterior and inferior to the liver
- posterior to the anterior abdominal wall
- anterior to the transverse colon and the proximal duodenum
- superior to the biliary tree and the duodenum.

Innervation

Inflammation of the gallbladder may present with pain in the right upper quadrant and also the right shoulder; this is due to irritation of the diaphragmatic visceral peritoneum innervated by the phrenic nerve (C3 – C5) that also innervate skin over the shoulder.

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Anatomy: Abdomen



Question 59 of 125

The flat anterior abdominal wall muscles are comprised of which of the following muscles:

a The external and internal oblique muscles

b The external, internal and innermost oblique muscles

c The external oblique, internal oblique and rectus abdominis muscles

d The external oblique, internal oblique and transversus abdominis muscles

e The rectus abdominis and transversus abdominis muscles

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Anatomy: Abdomen

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The flat anterior abdominal wall muscles are comprised of which of the following muscles:

a) **The external and internal oblique muscles** ✗
b) The external, internal and innermost oblique muscles
c) The external oblique, internal oblique and rectus abdominis muscles
d) The external oblique, internal oblique and transversus abdominis muscles ✓
e) The rectus abdominis and transversus abdominis muscles

Answer

The external oblique, internal oblique and transversus abdominis muscles comprise the flat anterior abdominal muscles.

Notes

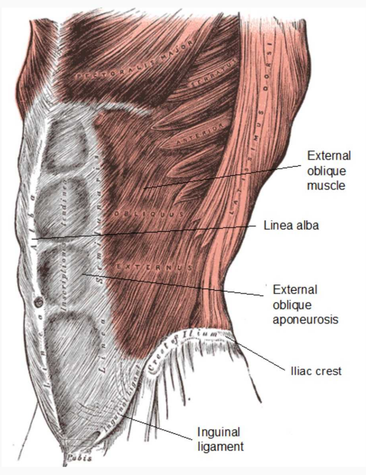
There are five muscles in the anterolateral group of abdominal wall muscles; three flat muscles whose fibres begin posterolaterally and pass anteriorly before being replaced by an aponeurosis as the muscle continues towards the midline (external oblique, internal oblique, transversus abdominis) and two vertical muscles enclosed by the tendinous sheath formed by the aponeuroses of the flat muscles (rectus abdominis, pyramidalis).

External oblique

The external oblique is the largest and most superficial of the anterior abdominal muscles, lying just deep to the superficial fascia. The external oblique originates from the outer surfaces of the lower eight ribs, its fibres running in an inferomedial direction before inserting onto the lateral lip of the iliac crest.

The external oblique has a large aponeurotic component that covers the anterior part of the abdominal wall and forms the linea alba at the midline, together with the aponeuroses from the internal oblique and the transversus abdominis. The linea alba extends from the xiphoid process to the pubic symphysis.

The lower free border of the external oblique aponeurosis forms the inguinal ligament on each side (which runs between the anterior superior iliac spine laterally and the pubic tubercle medially).



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Internal oblique

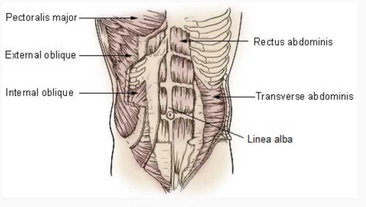
The internal oblique muscle lies deep to the external oblique. Its fibres run in a superomedial direction, originating from the thoracolumbar fascia, the iliac crest and the lateral two-thirds of the inguinal ligament and inserting onto the inferior border of the lower 3 – 4 ribs, the linea alba, the pubic crest and pectineal line.

Transversus abdominis

The transversus abdominis is the innermost of the flat anterior abdominal muscles, lying deep to the internal oblique. It originates from the thoracolumbar fascia, the iliac crest, the lateral one-third of the inguinal ligament and the 7th – 12th costal cartilages and inserts onto the linea alba, the pubic crest and the pectineal line.

Rectus abdominis

The rectus abdominis is a long muscle that extends the length of the anterior abdominal wall. It originates from the pubic crest, pubic tubercle and pubic symphysis and inserts onto the costal cartilages of ribs 5 – 7 and to the xiphoid process. It is a paired muscle, separated in the midline by the linea alba.



via Wikimedia Commons.

Function

The abdominal wall muscles form a firm, but flexible wall that keeps the abdominal viscera within the abdominal cavity, protects the viscera from injury and helps maintain the position of the viscera in the erect posture against the action of gravity.

The muscles act together to flex and rotate the vertebral column.

In addition, contraction of these muscles assists in forced expiration, and in coughing and vomiting, by pushing the viscera upwards. All of these muscles are involved in any action that increases intra-abdominal pressure, including childbirth, micturition and defaecation.

Innervation

The anterior abdominal wall muscles are innervated by the anterior rami of T7 – T12 and L1.

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Anatomy: Abdomen



Question 60 of 125

The lesser omentum extends between which of the following structures:

a The lesser curvature of the stomach to the liver

b The greater curvature of the stomach to the liver

c The greater curvature of the stomach to the transverse colon

d The lesser curvature of the stomach to the duodenojejunal junction

e The liver to the pancreas

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Anatomy: Abdomen

Question 60 of 125

The lesser omentum extends between which of the following structures:

a) The lesser curvature of the stomach to the liver ✔
b) The greater curvature of the stomach to the liver
c) The greater curvature of the stomach to the transverse colon
d) The lesser curvature of the stomach to the duodenojejunal junction
e) The liver to the pancreas

Answer

The lesser omentum is considerably smaller and extends from the lesser curvature of the stomach and the first part of the duodenum to the inferior surface of the liver.

Notes

Structure	Key anatomy
Peritoneal cavity	Divided into greater and lesser sacs
Greater sac	Divided into supracolic and infracolic compartments by transverse mesocolon, compartments connected by paracolic gutters
Supracolic compartment	Contains stomach, liver and spleen, lies under cover of costal limits of thoracic cage
Infracolic compartment	Divided into left and right parts by oblique attachment of mesentery, contains small intestine and ascending/descending colon, continuous with pelvic cavity
Lesser sac (omental bursa	Lies posterior to stomach and liver and anterior to pancreas, continuous with greater sac through epiploic foramen
Greater omentum	Descends from greater curvature of stomach and first part of duodenum, drapes inferiorly over transverse colon, jejunum and ileum, folds back up and ascends to adhere to transverse colon/mesocolon before arriving at posterior abdominal wall
Lesser omentum	Extends from lesser curvature of stomach and first part of duodenum to inferior surface of liver
Mesentery	Connects jejunum and ileus to posterior abdominal wall, attaches superiorly to duodenojejunal junction and passes oblique downwards and to the right to end at ileocecal junction
Transverse mesocolon	Connects transverse colon to posterior abdominal wall, leaves posterior abdominal wall across anterior surface of head and body of pancreas and passes outwards to surround transverse colon
Sigmoid mesocolon	Connects sigmoid colon to abdominal wall, V-shaped fold with apex near division of left common iliac artery, left limb descending along medial border of left psoas major muscle and right limb descending into pelvis to end at vertebral level S3

Compartments of the peritoneal cavity

The peritoneal cavity is divided into the greater sac and the omental bursa (lesser sac).

The greater sac accounts for most of the space in the peritoneal cavity, beginning superiorly at the diaphragm and continuing inferiorly in the pelvic cavity. It is further divided into two compartments by the transverse mesocolon:

- The supracolic compartment lies above the transverse mesocolon and contains the stomach, liver and spleen. It lies largely under cover of the costal limits of the thoracic cage.
- The infracolic compartment lies below the transverse mesocolon, is divided into left and right parts by the oblique attachment of the mesentery and contains the small intestine and the ascending and descending colon. The left infracolic compartment is continuous with the pelvic cavity.

The supracolic and infracolic compartments are connected by the paracolic gutters which lie between the posterolateral abdominal wall and the lateral aspect of the ascending or descending colon.

The omental bursa (lesser sac) is a smaller subdivision of the peritoneal cavity posterior to the stomach and liver and anterior to the pancreas, and is continuous with the greater sac through the epiploic foramen.

Omenta

The omenta are double layers of peritoneum that extends from the stomach and proximal part of the duodenum to other organs.

The greater omentum descends from the greater curvature of the stomach and first part of the duodenum, drapes inferiorly over the transverse colon and the coils of the jejunum and ileum, then folds back up posteriorly and ascends to become adherent to the peritoneum on the superior surface of the transverse colon and the anterior layer of the transverse mesocolon before arriving at the posterior abdominal wall.

The lesser omentum is considerably smaller and extends from the lesser curvature of the stomach and the first part of the duodenum to the inferior surface of the liver.

The greater omentum is often referred to as the 'policeman of the abdomen' because of its apparent ability to migrate to any inflamed area and wrap itself around the organ to wall off inflammation. The greater omentum is also an important site for metastatic tumour spread; direct omental spread by a transcoelomic route is common for carcinoma of the ovary.

Mesenteries

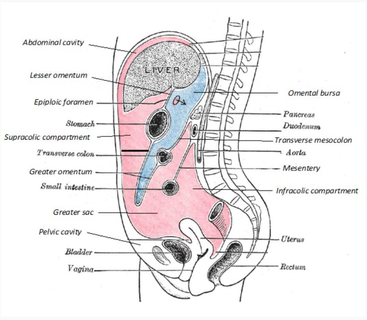
Mesenteries are peritoneal folds that attach viscera to the posterior abdominal wall. They allow some movement and provide a conduit for vessels, nerves and lymphatics to reach the viscera and include:

- the mesentery – associated with parts of the small intestine
- the transverse mesocolon – associated with transverse colon
- the sigmoid mesocolon – associated with the sigmoid colon.

The mesentery is a large, fan-shaped, double-layered fold of peritoneum that connects the jejunum and ileum to the posterior abdominal wall. Its superior attachment is at the duodenojejunal junction, just to the left of the upper lumbar part of the vertebral column. It passes obliquely downwards and to the right, ending at the ileocaecal junction near the upper border of the right sacroiliac joint.

The transverse mesocolon is a fold of peritoneum that connects the transverse colon to the posterior abdominal wall. It leaves the posterior abdominal wall across the anterior surface of the head and body of the pancreas and passes outwards to surround the transverse colon. Its anterior layer is adherent to the posterior layer of the greater omentum.

The sigmoid mesocolon is an inverted V-shaped peritoneal fold that attaches the sigmoid colon to the abdominal wall. The apex of the V is near the division of the left common iliac artery, with the left limb of the descending V along the medial border of the left psoas major muscle, and the right limb descending into the pelvis to end at the level of vertebra S3.



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Anatomy: Abdomen



Question 61 of 125

The arterial supply of the duodenum is primarily derived from which of the following:

a Superior mesenteric and inferior mesenteric artery

b Inferior mesenteric artery

c Left gastric artery and splenic artery

d Left gastric and superior mesenteric artery

e Gastroduodenal and superior mesenteric artery

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Anatomy: Abdomen

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The arterial supply of the duodenum is primarily derived from which of the following:

a) **Superior mesenteric and inferior mesenteric artery** ✗
b) Inferior mesenteric artery
c) Left gastric artery and splenic artery
d) Left gastric and superior mesenteric artery
e) Gastroduodenal and superior mesenteric artery ✓

Answer

The arterial supply of the duodenum is primarily from the pancreaticoduodenal arteries, branches of the superior mesenteric artery and the gastroduodenal artery (branch of the common hepatic artery from the coeliac trunk).

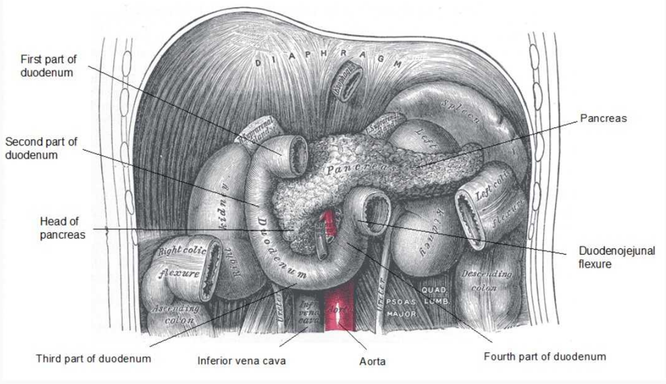
Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum. The first part of the small intestine is the duodenum.

The duodenum is a C-shaped structure, adjacent to the head of the pancreas, and above the level of the umbilicus. It is retroperitoneal except for its proximal part which is connected to the liver by the hepatoduodenal ligament of the lesser omentum.

Parts of the duodenum

- The superior (first) part extends from the pyloric orifice of the stomach to the neck of the gallbladder, lies just to the right of the body of vertebra L1, and passes anterior to the inferior vena cava and superior to the head of the pancreas.
- The descending (second) part is just to the right of the midline, extending from the neck of the gallbladder to the lower border of vertebra L3 and lying lateral to the head of the pancreas. This part contains the major duodenal papilla which is the common entrance for the bile and pancreatic ducts.
- The inferior (third) part is the longest section, crossing the inferior vena cava, the aorta and the vertebral column at the level of vertebra L3 and lying inferior to the pancreas.
- The ascending (fourth) part passes upwards on, or to the left of the aorta to approximately the upper border of vertebra L2 and terminates at the duodenojejunal flexure.



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Blood supply

The arterial supply of the duodenum is primarily from the pancreaticoduodenal arteries, branches of the superior mesenteric artery and the gastroduodenal artery (branch of the common hepatic artery from the coeliac trunk).

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Anatomy: Abdomen



Question 62 of 125

Which of the following structures is NOT a posterior relation of the transverse colon:

a Second part of duodenum

b Head of pancreas

c Upper end of mesentery

d Duodenojejunal flexure

e Spleen

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Which of the following structures is NOT a posterior relation of the transverse colon:

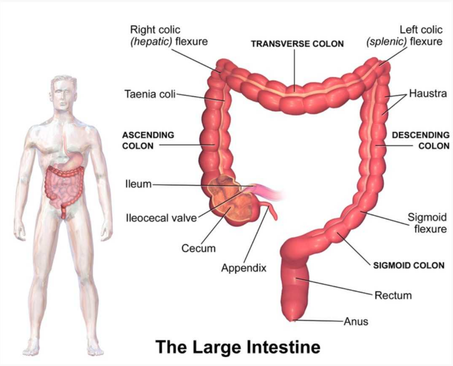
a) **Second part of duodenum** ✗
b) Head of pancreas
c) Upper end of mesentery
d) Duodenojejunal flexure
e) Spleen ✓

Answer

The transverse colon is related posteriorly to the second part of duodenum, the head of pancreas, the upper end of the mesentery, the duodenojejunal flexure and coils of jejunum and ileum. The spleen lies superior to the left colic flexure.

Notes

The large intestine extends from the distal end of the ileum to the anus, and comprises the caecum, appendix, colon, rectum and anal canal.



Blausen.com staff. "Blausen gallery 2014". Wikiversity Journal of Medicine. DOI:10.15347/wjm/2014.010. ISSN 20018762. (Own work) [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons

Colon

The colon continues from the caecum in the right groin as the ascending colon, which passes upwards through the right flank and into the right hypochondrium.

Just below the right lobe of the liver, it bends to the left forming the right colic flexure (hepatic flexure), and crosses the abdomen as the transverse colon to the left hypochondrium. The transverse colon is related superiorly to the liver, gallbladder, greater curvature of the stomach and the lateral end of the spleen.

At this point, just below the spleen, it bends downwards forming the left colic flexure (splenic flexure) and continues as the descending colon through the left flank and into the left groin. The splenic flexure is higher and more posterior than the hepatic flexure, and is attached to the diaphragm by the phrenicocolic ligament.

The colon enters the upper part of the pelvis as the sigmoid colon, which begins above the pelvic inlet and extends to the level of vertebra S3 where it is continuous with the rectum. This S-shaped structure is quite mobile except at its proximal and distal end which are attached to the descending colon and rectum respectively. Between these points, it is suspended by the sigmoid mesocolon.

The ascending and descending segments are retroperitoneal and the transverse and sigmoid segments are intraperitoneal.

Relations

Colon	Anterior relations	Posterior relations
Ascending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, right kidney
Transverse colon	Liver, gallbladder, stomach, greater omentum, anterior abdominal wall	Second part of duodenum, head of pancreas, upper end of mesentery, duodenojejunal flexure, coils of jejunum and ileum
Descending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, left kidney
Sigmoid colon	Bladder, uterus and upper vagina	Rectum, sacrum, ileum

Blood supply

The arterial supply to the colon is derived from the superior mesenteric artery (caecum, appendix, ascending colon, hepatic flexure, proximal two-thirds of transverse colon) and the inferior mesenteric artery (distal one-thirds of transverse colon, splenic flexure, descending colon, sigmoid colon).

As the terminal vessels of the superior mesenteric and inferior mesenteric artery approach the colon they split into many colic branches which anastomose with each other. These anastomoses from a continuous arterial channel which extends the length of the colon, the marginal artery.

At the junctional area of the supply of the superior and inferior mesenteric arteries, the anastomosis may not be sufficient, thus the splenic flexure is most susceptible to ischaemia.

Innervation

The visceral pain sensation from the ascending and transverse colon travels through the lesser splanchnic nerve to the T10 – T11 spinal cord segments hence pain is referred to the umbilical and hypogastric regions.

Pain from the descending and sigmoid colon is carried in the lumbar splanchnic nerves to the L1 and L2 spinal cord segments hence pain is referred to the inguinal region and thigh.

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Anatomy: Abdomen



Question 63 of 125

Which of the following structures does NOT pass through the inguinal canal:

a Genital branch of genitofemoral nerve

b Ilioinguinal nerve

c Spermatic cord

d Round ligament

e Inferior epigastric artery

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Anatomy: Abdomen

Question 63 of 125

Which of the following structures does NOT pass through the inguinal canal:

a) **Genital branch of genitofemoral nerve** ✗
b) Ilioinguinal nerve
c) Spermatic cord
d) Round ligament
e) Inferior epigastric artery ✓

Answer

The inferior epigastric artery does not pass through the inguinal canal.

The inguinal canal contains:

- the genital branch of the genitofemoral nerve (within the spermatic cord in men)
- the spermatic cord in men
- the round ligament in women
- the ilioinguinal nerve (passes through part of the canal, exiting the superficial inguinal ring with the other contents)

Notes

Space	Inguinal canal
Position	Between deep and superficial inguinal rings, just above and parallel to lower half of inguinal ligament
Anterior wall	Formed by external oblique aponeurosis (reinforced by internal oblique muscle laterally)
Posterior wall	Formed by transversalis fascia (reinforced by conjoint tendon medially)
Roof	Formed by transversus abdominis and internal oblique muscles
Floor	Formed by medial one-half of inguinal ligament (reinforced by lacunar ligament medially)
Deep inguinal ring	Opening in transversalis fascia, located just superior to mid-inguinal point (midway between ASIS and pubic symphysis)
Superficial inguinal ring	Opening in external oblique aponeurosis, located just superior to pubic tubercle
Contents	Genital branch of genitofemoral nerve, spermatic cord, round ligament, ilioinguinal nerve

Position

The inguinal canal is a slit-like passage that extends in a downwards and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the deep inguinal ring and continues for approximately 4 cm, ending at the superficial inguinal ring.

Roof, walls and floor

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle, and reinforced by the internal oblique muscle laterally.

The posterior wall of the inguinal canal is formed along its entire length by the transversalis fascia and reinforced by the conjoint tendon medially.

The roof of the inguinal canal is formed by arching fibres of the transversus abdominis and internal oblique muscles.

The floor of the inguinal canal is formed by the medial one-half of the inguinal ligament, reinforced medially by the lacunar ligament.

Deep inguinal ring

The deep inguinal ring, the opening in the transversalis fascia, is the beginning of the inguinal canal.

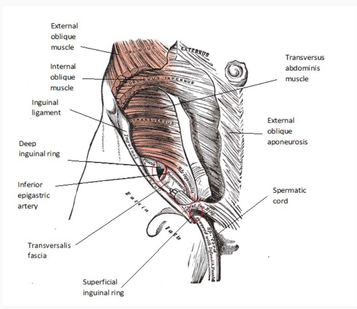
The deep inguinal ring is located just superior to a point midway between the anterior superior iliac spine and the pubic symphysis (the mid-inguinal point). N.B. Some sources state it is located at a slightly different site, just superior to a point midway between the anterior superior iliac spine and the pubic tubercle (the midpoint of the inguinal ligament).

It lies just above the inguinal ligament and immediately lateral to the inferior epigastric vessels; the femoral artery can be palpated in the same position but below the inguinal ligament.

Superficial inguinal ring

The superficial inguinal ring is the end of the inguinal canal.

The superficial inguinal ring is located just superior to the pubic tubercle. It is a triangular opening in the aponeurosis of the external oblique, with its apex pointing superolaterally and its base formed by the pubic crest.



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Contents

The inguinal canal contains:

- the genital branch of the genitofemoral nerve (within the spermatic cord in men)
- the spermatic cord in men
- the round ligament in women
- the ilioinguinal nerve (passes through part of the canal, exiting the superficial inguinal ring with the other contents)

Inguinal hernia

An inguinal hernia is the protrusion of a peritoneal sac through a weakened part of the abdominal wall in the groin.

Hernia	Indirect inguinal hernia	Direct inguinal hernia
Aetiology	Congenital – patent processus vaginalis	Acquired – weakened abdominal musculature
Mechanism	Peritoneal sac herniates through deep inguinal ring	Peritoneal sac herniates directly through posterior wall of inguinal canal
Relation to inferior epigastric vessels	Lateral to inferior epigastric vessels	Medial to inferior epigastric vessels

In indirect inguinal hernias, the most common type, the peritoneal sac enters the inguinal canal by passing through the deep inguinal ring, due to a patent embryonic processus vaginalis. If the entire processus vaginalis remains patent, the peritoneal sac may traverse the length of the canal, exit the superficial inguinal ring and continue into the scrotum or labia majora.

In direct inguinal hernias, the peritoneal sac passes directly through the posterior wall of the inguinal canal. It usually occurs when abdominal musculature has been weakened, in older men, following surgery or due to persistent raised intra-abdominal pressure. This type of hernia does not traverse the inguinal canal, but may still exit the superficial inguinal ring to enter the scrotum.

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Anatomy: Abdomen



Question 64 of 125

A 75 year old man presents to ED complaining of abdominal pain radiating to his back, anorexia and weight loss. Imaging shows a large tumour of the neck of the pancreas. Which of the following structures is most likely compressed by the tumour:

a Inferior mesenteric artery

b Portal vein

c First part of the duodenum

d Ureter

e Coeliac trunk

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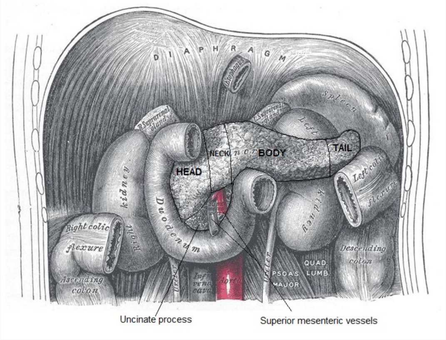
a) **Inferior mesenteric artery** ✗
b) Portal vein ✓
c) First part of the duodenum
d) Ureter
e) Coeliac trunk

Answer

The portal vein is formed from the union of the superior mesenteric and splenic veins posterior to the neck of the pancreas and would most likely be compressed by a tumour at this location.

Notes

The pancreas lies mostly posterior to the stomach. It extends across the posterior abdominal wall from the duodenum on the right, to the spleen on the left. It lies in the epigastric region and left hypochondrium. The pancreas is a retroperitoneal organ (except for a small part of its tail) and consists of a head, uncinate process, neck, body and tail.

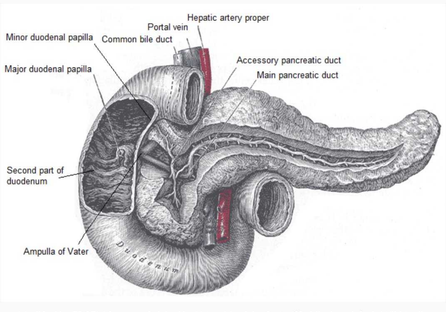


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Relations

- The head of the pancreas lies within the C-shaped concavity of the duodenum. The head is related anteriorly to the first part of the duodenum, the transverse colon and coils of jejunum and posteriorly to the common bile duct and the inferior vena cava and the termination of the renal veins.
- The uncinate process projects from the lower part of the head and passes posterior to the superior mesenteric vessels.
- The neck is anterior to the superior mesenteric vessels. Posterior to the neck of the pancreas, the superior mesenteric and splenic veins join to form the portal vein.
- The body is elongated and extends from the neck to the tail of the pancreas in the transpyloric plane (at the level of vertebra L1) to lie behind the stomach and to the left of the superior mesenteric vessels.
- The intraperitoneal tail passes between layers of the splenorenal ligament. It is related to the left kidney posteriorly, the hilum of the spleen laterally, the left colic flexure inferiorly and the stomach anteriorly.

The pancreatic duct begins in the tail of the pancreas and passes to the right, through the body and to the head where it turns inferiorly and joins the bile duct forming the hepatopancreatic ampulla (ampulla of Vater) which enters the second part of the duodenum at the major duodenal papilla. The accessory pancreatic duct empties into the duodenum just above the major duodenal papilla at the minor duodenal papilla.



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Blood supply

The arterial supply to the pancreas is primarily derived from the splenic artery from the coeliac trunk, assisted by branches from the gastroduodenal artery (from the common hepatic artery from the coeliac trunk), and from the superior mesenteric artery.

Venous drainage of the head of the pancreas is via pancreaticoduodenal veins into the superior mesenteric vein and portal vein. Venous drainage of the body and tail of the pancreas is via pancreatic veins into the splenic vein.

Lymphatics

Lymphatics draining the pancreas empty into the pancreaticosplenic nodes and the pyloric nodes, which in turn drain into the superior mesenteric and celiac pre-aortic lymph nodes.

Innervation

Visceral afferent fibres travel in the greater and lesser splanchnic nerves. The segmental level of innervation is T6 – T10. Pain typically radiates to the middle of the back due to irritation of the parietal peritoneum covering the pancreas.

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Anatomy: Abdomen



Question 65 of 125

The caudate lobe of the liver lies between which of the following structures:

a Ligamentum teres and gallbladder

b Ligamentum venosum and gallbladder

c Ligamentum teres and inferior vena cava

d Ligamentum venosum and inferior vena cava

e Gallbladder and inferior vena cava

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a) Ligamentum teres and gallbladder ✗
b) Ligamentum venosum and gallbladder
c) Ligamentum teres and inferior vena cava
d) Ligamentum venosum and inferior vena cava ✓
e) Gallbladder and inferior vena cava

Answer

The caudate lobe sits between the fissure for the ligamentum venosum and the inferior vena cava.

Notes

The liver is the largest visceral organ in the body and is primarily located in the right hypochondrium and epigastric region, extending into the left hypochondrium.

Surface marking

Most of the liver is under the right dome of the diaphragm and deep to the lower thoracic wall. The inferior margin of the liver can be palpated descending below the right costal margin on deep inspiration.

The inferior margin is indicated by a line that joins points at the right tenth costal cartilage in the midaxillary line, the tip of the right ninth costal cartilage, the transpyloric plane in the midline, the tip of the left eighth costal cartilage and the left fifth rib in the midclavicular line.

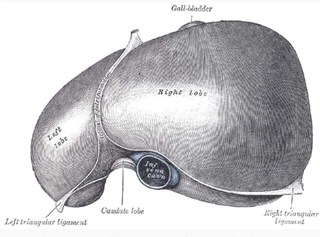
The superior margin is indicated by a line that joints a point on the left fifth rib at the midclavicular line to a corresponding point on the right side. The superior margin is concave in its central part and crosses behind the xiphisternal joint.

Anatomical surfaces

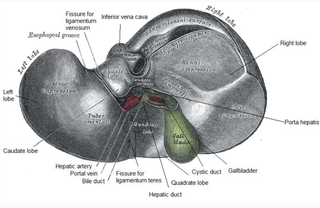
The liver has a diaphragmatic surface in the anterior, superior, and posterior directions and a visceral surface in the inferior direction.

The diaphragmatic surface of the liver is related anteriorly to the anterior abdominal wall and rib cage and superiorly to the diaphragm.

The visceral surface of the liver is related to the oesophagus, right anterior part of the stomach, superior part of the duodenum, lesser omentum, gallbladder, right colic flexure, right transverse colon, right kidney and right adrenal gland.



Diaphragmatic surface of liver. By Henry Vandyke Carter [Public domain], via Wikimedia Commons



Inferior surface of liver. Modified by FRCEM Success. Original by Henry Vandyke Carter [Public domain], via Wikimedia Commons

Lobes

There are four anatomical lobes to the liver.

- The liver is divided into the left and right lobe by the fossae for the gallbladder and the inferior vena cava.
- The caudate lobe sits between the fissure for the ligamentum venosum and the inferior vena cava.
- The quadrate lobe is located between the gallbladder and the fissure for the ligamentum teres.

The porta hepatis is the central intraperitoneal fissure of the liver that separates the caudate and the quadrate lobes. The porta hepatis serves as the point of entry into the liver for the hepatic arteries and portal vein, and the exit point for the hepatic ducts.

Liver lobules

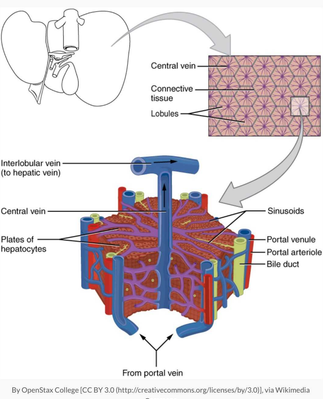
Microscopically, hepatocytes are arranged into lobules which are the functional units of the liver. Each lobule is hexagonal-shaped, and is drained by a venule in its centre, called a central vein (which drains to the hepatic vein).

At the periphery of the hexagon are three structures collectively known as the portal triad, comprising:

- a portal arteriole (a branch of the hepatic artery),
- a portal venule (a branch of the hepatic portal vein),
- a bile duct.

The portal triad also contains lymphatic vessels and vagal parasympathetic nerve fibres.

The liver sinusoids serve as a location for mixing of the oxygen-rich blood from the hepatic artery and the nutrient-rich blood from the portal vein.



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Blood supply

The liver has a unique dual blood supply. The arterial supply to the liver is from the left and right hepatic arteries derived from the hepatic artery proper, a branch of the common hepatic artery from the coeliac trunk.

The hepatic portal vein (formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2) supplies the liver with deoxygenated blood carrying nutrients absorbed from the small intestine.

Venous drainage of the liver is achieved through three hepatic veins, which return the venous blood to the inferior vena cava just inferior to the diaphragm.

Lymphatic drainage

The lymphatic vessels of the liver drain into hepatic lymph nodes which empty in the coeliac lymph nodes.

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Anatomy: Abdomen



Question 66 of 125

A 29 year old man with HIV presents to ED with a painful blistering rash that has erupted on the skin around the umbilicus. You diagnose shingles. Which of the following spinal nerves supplies this dermatome:

a T8

b T9

c T10

d T11

e T12

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Anatomy: Abdomen

Question 66 of 125

A 29 year old man with HIV presents to ED with a painful blistering rash that has erupted on the skin around the umbilicus. You diagnose shingles. Which of the following spinal nerves supplies this dermatome:

a) T8 ✗
b) T9
c) T10 ✓
d) T11
e) T12

Answer

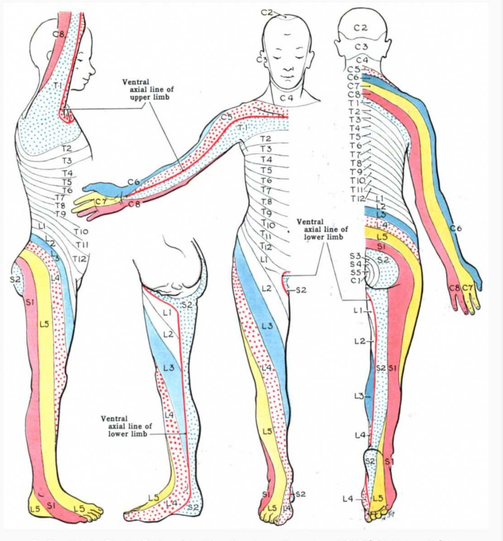
The T10 dermatome is located at the level of the umbilicus.

Notes

Dermatome	Landmark
T1	Medial antecubital fossa
T2	Apex of axilla
T3	Third intercostal space
T4	Level of nipples (fourth intercostal space)
T5	Fifth intercostal space
T6	Level of xiphisternum
T7	One-quarter distance between xiphisternum and umbilicus
T8	One-half distance between xiphisternum and umbilicus
T9	Three-quarter distance between xiphisternum and umbilicus
T10	Level of umbilicus
T11	Midway between umbilicus and inguinal ligament
T12	Midpoint of inguinal ligament

Dermatome assessment

- The T1 dermatome is best tested on the medial (ulnar) side of the antecubital fossa, just proximal to the medial epicondyle of the humerus.
- The T2 dermatome is best tested at the apex of the axilla.
- The T3 dermatome is best tested at the midclavicular line and the third intercostal space.
- The T4 dermatome is best tested at the midclavicular line and the fourth intercostal space, located at the level of the nipples.
- The T5 dermatome is best tested at the midclavicular line and the fifth intercostal space, located midway between the level of the nipples and the level of the xiphisternum.
- The T6 dermatome is best tested at the midclavicular line, located at the level of the xiphisternum.
- The T7 dermatome is best tested at the midclavicular line, one quarter the distance between the level of the xiphisternum and the level of the umbilicus.
- The T8 dermatome is best tested at the midclavicular line, one half the distance between the level of the xiphisternum and the level of the umbilicus.
- The T9 dermatome is best tested at the midclavicular line, three quarters of the distance between the level of the xiphisternum and the level of the umbilicus.
- The T10 dermatome is best tested at the midclavicular line, located at the level of the umbilicus.
- The T11 dermatome is best tested at the midclavicular line, midway between the level of the umbilicus and the inguinal ligament.
- The T12 dermatome is best tested at the midclavicular line, over the midpoint of the inguinal ligament.



By Grant, John Charles Boileau (An atlas of anatomy, / by regions 1962) [Public domain], via Wikimedia Commons

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Anatomy: Abdomen



Question 67 of 125

The ileum predominantly occupies which region of the abdomen:

a Left upper quadrant

b Right upper quadrant

c Left lower quadrant

d Right lower quadrant

e Epigastric region

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Anatomy: Abdomen

Question 67 of 125

The ileum predominantly occupies which region of the abdomen:

a) **Left upper quadrant** ✗
b) Right upper quadrant
c) Left lower quadrant
d) Right lower quadrant ✓
e) Epigastric region

Answer

The ileum is mostly in the right lower quadrant.

Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum.

The jejunum and ileum make up the last two sections of the small intestine.

The jejunum and ileum are intraperitoneal, attached to the posterior abdominal wall by the mesentery.

Jejunum

The jejunum represents the proximal two-fifths. It is mostly in the left upper quadrant of the abdomen and is larger in diameter and has a thicker wall than the ileum.

Ileum

The ileum makes up the distal three-fifths and is mostly in the right lower quadrant. The ileum invaginates into the large intestine at the ileocaecal junction forming the ileocaecal valve, which prevents reflux from the caecum to the ileum and regulates the passage of contents from the ileum to the caecum.

Blood supply

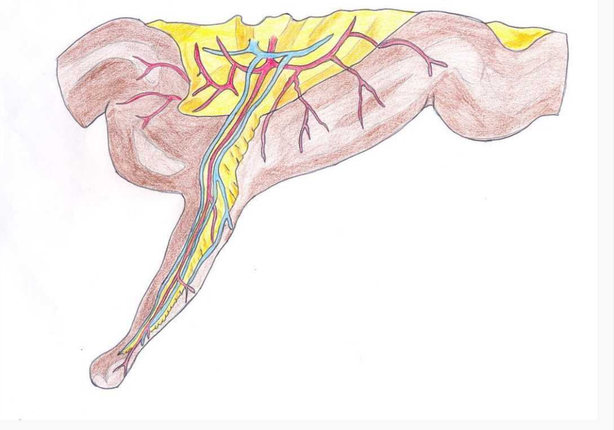
The arterial supply to the jejunum and ileum is derived from the superior mesenteric artery.

Innervation

The sympathetic nerve supply is derived from the T9 – T10 spinal cord segments. Pain from the small jejunum and ileum is referred to the peri-umbilical region.

Meckel's diverticulum

A Meckel's diverticulum is the remnant of the proximal part of the yolk stalk (vitelline duct) that extends into the umbilical cord in the embryo and lies on the antimesenteric border of the ileum, approximately **2 feet** proximal to the ileocaecal junction. It appears as a blind-ended tubular outpouching of bowel, about **2 inches** long, occurring in about **2%** of the population, and may contain **two types** of ectopic tissue (gastric and pancreatic). Complications include haemorrhage, intussusception, diverticulitis, ulceration and obstruction, and symptoms may mimic those of acute appendicitis.



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Anatomy: Abdomen



Question 68 of 125

Which of the following best describes the relationship of the duodenum to the pancreas:

a The first part of the duodenum lies superior to the tail of the pancreas.

b The second part of the duodenum lies medial to the head of the pancreas.

c The third part of the duodenum lies inferior to the pancreas.

d The fourth part of the duodenum lies inferior to the head of the pancreas.

e The head of the pancreas lies posterior to the second part of the duodenum.

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Anatomy: Abdomen

Question 68 of 125

Which of the following best describes the relationship of the duodenum to the pancreas:

a) **The first part of the duodenum lies superior to the tail of the pancreas.** ✗
b) The second part of the duodenum lies medial to the head of the pancreas.
c) The third part of the duodenum lies inferior to the pancreas. ✓
d) The fourth part of the duodenum lies inferior to the head of the pancreas.
e) The head of the pancreas lies posterior to the second part of the duodenum.

Answer

The first part of the duodenum lies superior to the head of the pancreas. The second part of the duodenum lies immediately lateral to the head of the pancreas. The third part of the duodenum lies inferior to the pancreas. The fourth part of the duodenum does not lie inferior to the head of the pancreas.

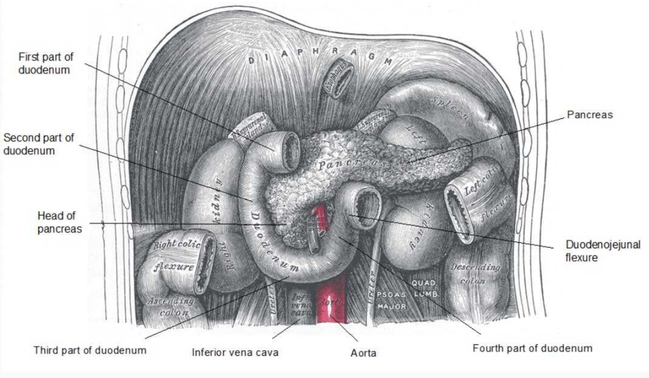
Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum. The first part of the small intestine is the duodenum.

The duodenum is a C-shaped structure, adjacent to the head of the pancreas, and above the level of the umbilicus. It is retroperitoneal except for its proximal part which is connected to the liver by the hepatoduodenal ligament of the lesser omentum.

Parts of the duodenum

- The superior (first) part extends from the pyloric orifice of the stomach to the neck of the gallbladder, lies just to the right of the body of vertebra L1, and passes anterior to the inferior vena cava and superior to the head of the pancreas.
- The descending (second) part is just to the right of the midline, extending from the neck of the gallbladder to the lower border of vertebra L3 and lying lateral to the head of the pancreas. This part contains the major duodenal papilla which is the common entrance for the bile and pancreatic ducts.
- The inferior (third) part is the longest section, crossing the inferior vena cava, the aorta and the vertebral column at the level of vertebra L3 and lying inferior to the pancreas.
- The ascending (fourth) part passes upwards on, or to the left of the aorta to approximately the upper border of vertebra L2 and terminates at the duodenojejunal flexure.



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Blood supply

The arterial supply of the duodenum is primarily from the pancreaticoduodenal arteries, branches of the superior mesenteric artery and the gastroduodenal artery (branch of the common hepatic artery from the coeliac trunk).

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Anatomy: Abdomen



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Which of the following structures is NOT retroperitoneal:

a Abdominal oesophagus

b Adrenal glands

c Ascending colon

d Descending colon

e Proximal duodenum

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Anatomy: Abdomen

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Which of the following structures is NOT retroperitoneal:

a) **Abdominal oesophagus** ✗
b) Adrenal glands
c) Ascending colon
d) Descending colon
e) Proximal duodenum ✓

Answer

The second and third parts of the duodenum are retroperitoneal, the first part is intraperitoneal.

Notes

The peritoneum is a continuous double-layered serous membrane.

The parietal peritoneum lines the walls of the abdominal cavity and the visceral peritoneum lines the viscera.

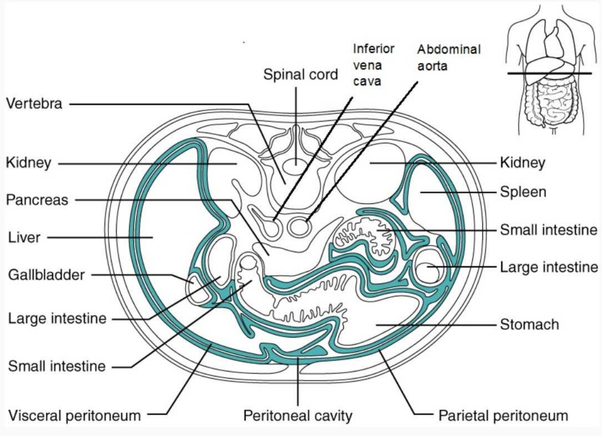
Between the parietal and visceral layers of peritoneum is a potential space, the peritoneal cavity.

Abdominal viscera are either suspended in the peritoneal cavity by folds of peritoneum called mesenteries (intraperitoneal viscera) or are outside the peritoneal cavity bound to the posterior abdominal wall (retroperitoneal viscera). Retroperitoneal organs are only covered in peritoneum on their anterior surface.

Innervation

The parietal peritoneum associated with the abdominal wall is innervated by somatic afferents carried in branches of the associated spinal nerves and is therefore sensitive to pressure, pain and temperature, and gives rise to well-localised pain. The diaphragmatic peritoneum is supplied by the phrenic nerve (C3 – C5) and the remainder of the parietal peritoneum is supplied segmentally by intercostal and lumbar nerves.

The visceral peritoneum is innervated by visceral afferents that accompany autonomic nerves back to the CNS and therefore activation gives rise to referred and poorly localised sensations of discomfort and to visceral motor activity.



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Retroperitoneal viscera

A useful mnemonic to help remember which abdominal organs are retroperitoneal is SAD PUCKER:

- Suprarenal glands
- Aorta and Inferior vena cava
- Duodenum (2nd and 3rd parts)
- Pancreas (except for the tail)
- Ureters (proximal) and Bladder
- Colon (ascending and descending)
- Kidneys
- (O)esophagus
- Rectum (lower two-thirds)

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Anatomy: Abdomen



Question 70 of 125

The greater omentum descends from which of the following structures:

a The quadrate lobe of the liver

b The lesser curvature of the stomach and first part of the duodenum

c The greater curvature of the stomach and first part of the duodenum

d The transverse colon

e The duodenojejunal junction

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Anatomy: Abdomen

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The greater omentum descends from which of the following structures:

a) **The quadrate lobe of the liver** ✗
b) The lesser curvature of the stomach and first part of the duodenum
c) The greater curvature of the stomach and first part of the duodenum ✓
d) The transverse colon
e) The duodenojejunal junction

Answer

The greater omentum descends from the greater curvature of the stomach and first part of the duodenum, drapes inferiorly over the transverse colon and the coils of the jejunum and ileum, then folds back up posteriorly and ascends to become adherent to the peritoneum on the superior surface of the transverse colon and the anterior layer of the transverse mesocolon before arriving at the posterior abdominal wall.

Notes

Structure	Key anatomy
Peritoneal cavity	Divided into greater and lesser sacs
Greater sac	Divided into supracolic and infracolic compartments by transverse mesocolon, compartments connected by paracolic gutters
Supracolic compartment	Contains stomach, liver and spleen, lies under cover of costal limits of thoracic cage
Infracolic compartment	Divided into left and right parts by oblique attachment of mesentery, contains small intestine and ascending/descending colon, continuous with pelvic cavity
Lesser sac (omental bursa	Lies posterior to stomach and liver and anterior to pancreas, continuous with greater sac through epiploic foramen
Greater omentum	Descends from greater curvature of stomach and first part of duodenum, drapes inferiorly over transverse colon, jejunum and ileum, folds back up and ascends to adhere to transverse colon/mesocolon before arriving at posterior abdominal wall
Lesser omentum	Extends from lesser curvature of stomach and first part of duodenum to inferior surface of liver
Mesentery	Connects jejunum and ileus to posterior abdominal wall, attaches superiorly to duodenojejunal junction and passes oblique downwards and to the right to end at ileocecal junction
Transverse mesocolon	Connects transverse colon to posterior abdominal wall, leaves posterior abdominal wall across anterior surface of head and body of pancreas and passes outwards to surround transverse colon
Sigmoid mesocolon	Connects sigmoid colon to abdominal wall, V-shaped fold with apex near division of left common iliac artery, left limb descending along medial border of left psoas major muscle and right limb descending into pelvis to end at vertebral level S3

Compartments of the peritoneal cavity

The peritoneal cavity is divided into the greater sac and the omental bursa (lesser sac).

The greater sac accounts for most of the space in the peritoneal cavity, beginning superiorly at the diaphragm and continuing inferiorly in the pelvic cavity. It is further divided into two compartments by the transverse mesocolon:

- The supracolic compartment lies above the transverse mesocolon and contains the stomach, liver and spleen. It lies largely under cover of the costal limits of the thoracic cage.
- The infracolic compartment lies below the transverse mesocolon, is divided into left and right parts by the oblique attachment of the mesentery and contains the small intestine and the ascending and descending colon. The left infracolic compartment is continuous with the pelvic cavity.

The supracolic and infracolic compartments are connected by the paracolic gutters which lie between the posterolateral abdominal wall and the lateral aspect of the ascending or descending colon.

The omental bursa (lesser sac) is a smaller subdivision of the peritoneal cavity posterior to the stomach and liver and anterior to the pancreas, and is continuous with the greater sac through the epiploic foramen.

Omenta

The omenta are double layers of peritoneum that extends from the stomach and proximal part of the duodenum to other organs.

The greater omentum descends from the greater curvature of the stomach and first part of the duodenum, drapes inferiorly over the transverse colon and the coils of the jejunum and ileum, then folds back up posteriorly and ascends to become adherent to the peritoneum on the superior surface of the transverse colon and the anterior layer of the transverse mesocolon before arriving at the posterior abdominal wall.

The lesser omentum is considerably smaller and extends from the lesser curvature of the stomach and the first part of the duodenum to the inferior surface of the liver.

The greater omentum is often referred to as the 'policeman of the abdomen' because of its apparent ability to migrate to any inflamed area and wrap itself around the organ to wall off inflammation. The greater omentum is also an important site for metastatic tumour spread; direct omental spread by a transcoelomic route is common for carcinoma of the ovary.

Mesenteries

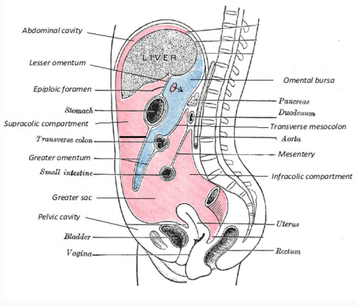
Mesenteries are peritoneal folds that attach viscera to the posterior abdominal wall. They allow some movement and provide a conduit for vessels, nerves and lymphatics to reach the viscera and include:

- the mesentery – associated with parts of the small intestine
- the transverse mesocolon – associated with transverse colon
- the sigmoid mesocolon – associated with the sigmoid colon.

The mesentery is a large, fan-shaped, double-layered fold of peritoneum that connects the jejunum and ileum to the posterior abdominal wall. Its superior attachment is at the duodenojejunal junction, just to the left of the upper lumbar part of the vertebral column. It passes obliquely downwards and to the right, ending at the ileocaecal junction near the upper border of the right sacroiliac joint.

The transverse mesocolon is a fold of peritoneum that connects the transverse colon to the posterior abdominal wall. It leaves the posterior abdominal wall across the anterior surface of the head and body of the pancreas and passes outwards to surround the transverse colon. Its anterior layer is adherent to the posterior layer of the greater omentum.

The sigmoid mesocolon is an inverted V-shaped peritoneal fold that attaches the sigmoid colon to the abdominal wall. The apex of the V is near the division of the left common iliac artery, with the left limb of the descending V along the medial border of the left psoas major muscle, and the right limb descending into the pelvis to end at the level of vertebra S3.



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Anatomy: Abdomen



Question 71 of 125

The stomach lies anterior to all of the following structures EXCEPT for the:

a Pancreas

b Transverse mesocolon

c Spleen

d Left lobe of the liver

e Left colic flexure

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Anatomy: Abdomen

Question 71 of 125

The stomach lies anterior to all of the following structures EXCEPT for the:

a) Pancreas ✖
b) Transverse mesocolon
c) Spleen
d) Left lobe of the liver ✔
e) Left colic flexure

Answer

The left lobe of the liver lies anterior to the stomach.

Notes

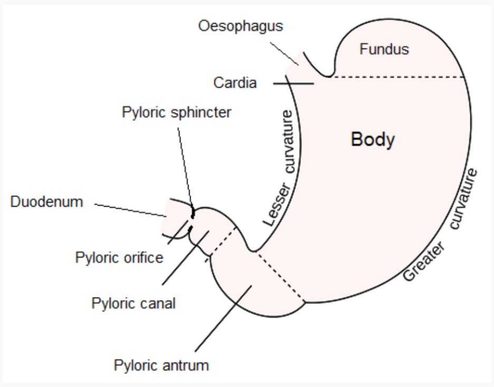
The stomach is the most dilated part of the gastrointestinal tract and has a J-like shape. The stomach is in the epigastric, umbilical and left hypochondriac regions of the abdomen. It is an intraperitoneal organ.

Anatomical distinctions

The stomach is divided into four regions:

- the cardia which surrounds the opening of the oesophagus into the stomach
- the fundus which is the area above the level of the cardiac orifice
- the body which is the largest central region of the stomach
- the pyloric part which is divided into the pyloric antrum and the pyloric canal which opens into the duodenum.

The most distal portion of the pyloric canal contains a thickened ring of gastric circular muscle, the pyloric sphincter that surrounds the distal pyloric orifice. The pyloric orifice is just to the right of the midline in the transpyloric plane. The pyloric sphincter controls the exit of chyme from the stomach into the duodenum. The sphincter is constricted by sympathetic stimulation and relaxed by parasympathetic action. Parasympathetic fibres in the vagus nerve are also secretomotor to gastric glands and motor to muscular wall of stomach.



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Relations

The stomach lies inferior to the diaphragm.

The stomach lies posterior to:

- the anterior abdominal wall
- the left costal margin
- the left lobe of the liver

The stomach lies anterior to the stomach bed formed by:

- the diaphragm
- the pancreas
- the transverse mesocolon
- the left colic flexure
- the left kidney
- the left adrenal gland
- the spleen

Blood supply

The arterial supply to the stomach is derived from all three branches (left gastric, splenic and common hepatic branches) of the coeliac trunk.

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Anatomy: Abdomen



Question 72 of 125

The body of the pancreas lies at which of the following vertebral levels:

a T11

b T12

c L1

d L2

e L3

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Anatomy: Abdomen

Question 72 of 125

The body of the pancreas lies at which of the following vertebral levels:

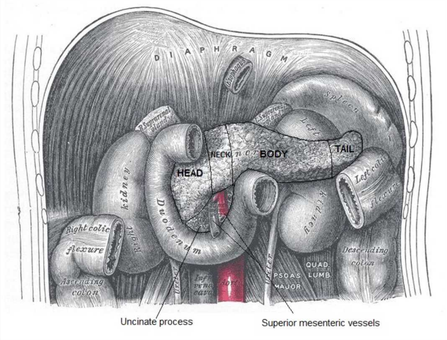
a) T11
b) T12
c) L1 ✔
d) L2
e) L3

Answer

The body of the pancreas is elongated and extends from the neck to the tail of the pancreas in the transpyloric plane (at the level of vertebra L1) to lie behind the stomach and to the left of the superior mesenteric vessels.

Notes

The pancreas lies mostly posterior to the stomach. It extends across the posterior abdominal wall from the duodenum on the right, to the spleen on the left. It lies in the epigastric region and left hypochondrium. The pancreas is a retroperitoneal organ (except for a small part of its tail) and consists of a head, uncinate process, neck, body and tail.

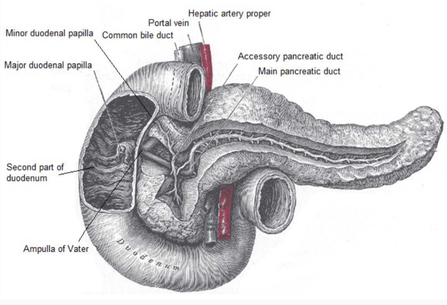


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Relations

- The head of the pancreas lies within the C-shaped concavity of the duodenum. The head is related anteriorly to the first part of the duodenum, the transverse colon and coils of jejunum and posteriorly to the common bile duct and the inferior vena cava and the termination of the renal veins.
- The uncinate process projects from the lower part of the head and passes posterior to the superior mesenteric vessels.
- The neck is anterior to the superior mesenteric vessels. Posterior to the neck of the pancreas, the superior mesenteric and splenic veins join to form the portal vein.
- The body is elongated and extends from the neck to the tail of the pancreas in the transpyloric plane (at the level of vertebra L1) to lie behind the stomach and to the left of the superior mesenteric vessels.
- The intraperitoneal tail passes between layers of the splenorenal ligament. It is related to the left kidney posteriorly, the hilum of the spleen laterally, the left colic flexure inferiorly and the stomach anteriorly.

The pancreatic duct begins in the tail of the pancreas and passes to the right, through the body and to the head where it turns inferiorly and joins the bile duct forming the hepatopancreatic ampulla (ampulla of Vater) which enters the second part of the duodenum at the major duodenal papilla. The accessory pancreatic duct empties into the duodenum just above the major duodenal papilla at the minor duodenal papilla.



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Blood supply

The arterial supply to the pancreas is primarily derived from the splenic artery from the coeliac trunk, assisted by branches from the gastroduodenal artery (from the common hepatic artery from the coeliac trunk), and from the superior mesenteric artery.

Venous drainage of the head of the pancreas is via pancreaticoduodenal veins into the superior mesenteric vein and portal vein. Venous drainage of the body and tail of the pancreas is via pancreatic veins into the splenic vein.

Lymphatics

Lymphatics draining the pancreas empty into the pancreaticosplenic nodes and the pyloric nodes, which in turn drain into the superior mesenteric and celiac pre-aortic lymph nodes.

Innervation

Visceral afferent fibres travel in the greater and lesser splanchnic nerves. The segmental level of innervation is T6 – T10. Pain typically radiates to the middle of the back due to irritation of the parietal peritoneum covering the pancreas.

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Anatomy: Abdomen



Question 73 of 125

A 23 year old patient is brought to ED following a road traffic accident. CT imaging demonstrates retroperitoneal injury. Which of the following organs is most likely affected:

a Bladder

b Spleen

c Appendix

d Sigmoid colon

e Tail of pancreas

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Anatomy: Abdomen

Question 73 of 125

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a) Bladder ✔
b) Spleen
c) Appendix
d) Sigmoid colon
e) Tail of pancreas ✖

Answer

The bladder is the only organ listed that is retroperitoneal.

Notes

The peritoneum is a continuous double-layered serous membrane.

The parietal peritoneum lines the walls of the abdominal cavity and the visceral peritoneum lines the viscera.

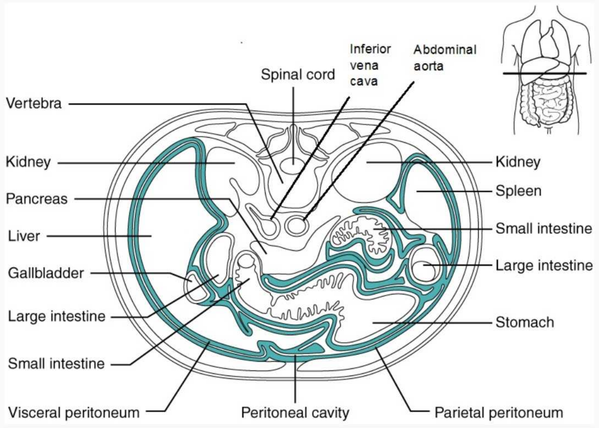
Between the parietal and visceral layers of peritoneum is a potential space, the peritoneal cavity.

Abdominal viscera are either suspended in the peritoneal cavity by folds of peritoneum called mesenteries (intraperitoneal viscera) or are outside the peritoneal cavity bound to the posterior abdominal wall (retroperitoneal viscera). Retroperitoneal organs are only covered in peritoneum on their anterior surface.

Innervation

The parietal peritoneum associated with the abdominal wall is innervated by somatic afferents carried in branches of the associated spinal nerves and is therefore sensitive to pressure, pain and temperature, and gives rise to well-localised pain. The diaphragmatic peritoneum is supplied by the phrenic nerve (C3 – C5) and the remainder of the parietal peritoneum is supplied segmentally by intercostal and lumbar nerves.

The visceral peritoneum is innervated by visceral afferents that accompany autonomic nerves back to the CNS and therefore activation gives rise to referred and poorly localised sensations of discomfort and to visceral motor activity.



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Retroperitoneal viscera

A useful mnemonic to help remember which abdominal organs are retroperitoneal is SAD PUCKER:

- Suprarenal glands
- Aorta and Inferior vena cava
- Duodenum (2nd and 3rd parts)
- Pancreas (except for the tail)
- Ureters (proximal) and Bladder
- Colon (ascending and descending)
- Kidneys
- (O)esophagus
- Rectum (lower two-thirds)

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Anatomy: Abdomen



Question 74 of 125

Which of the following is a retroperitoneal structure:

- a Sigmoid colon
- b Second part of duodenum
- c Ileum
- d Liver
- e Spleen

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Anatomy: Abdomen

Question 74 of 125

Which of the following is a retroperitoneal structure:

a) Sigmoid colon ✖
b) Second part of duodenum ✔
c) Ileum
d) Liver
e) Spleen

Answer

The second and third parts of the duodenum are retroperitoneal.

Notes

The peritoneum is a continuous double-layered serous membrane.

The parietal peritoneum lines the walls of the abdominal cavity and the visceral peritoneum lines the viscera.

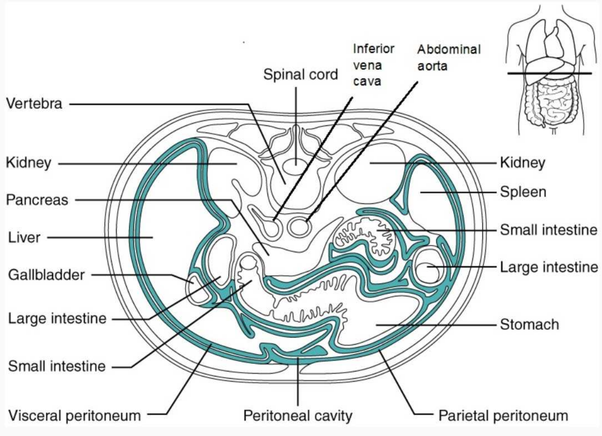
Between the parietal and visceral layers of peritoneum is a potential space, the peritoneal cavity.

Abdominal viscera are either suspended in the peritoneal cavity by folds of peritoneum called mesenteries (intraperitoneal viscera) or are outside the peritoneal cavity bound to the posterior abdominal wall (retroperitoneal viscera). Retroperitoneal organs are only covered in peritoneum on their anterior surface.

Innervation

The parietal peritoneum associated with the abdominal wall is innervated by somatic afferents carried in branches of the associated spinal nerves and is therefore sensitive to pressure, pain and temperature, and gives rise to well-localised pain. The diaphragmatic peritoneum is supplied by the phrenic nerve (C3 – C5) and the remainder of the parietal peritoneum is supplied segmentally by intercostal and lumbar nerves.

The visceral peritoneum is innervated by visceral afferents that accompany autonomic nerves back to the CNS and therefore activation gives rise to referred and poorly localised sensations of discomfort and to visceral motor activity.



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- Suprarenal glands
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- Duodenum (2nd and 3rd parts)
- Pancreas (except for the tail)
- Ureters (proximal) and Bladder
- Colon (ascending and descending)
- Kidneys
- (O)esophagus
- Rectum (lower two-thirds)

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Anatomy: Abdomen



Question 75 of 125

The stomach receives its blood supply primarily from which of the following arteries:

a Superior mesenteric artery

b Inferior mesenteric artery

c Coeliac trunk

d Renal artery

e Suprarenal artery

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Anatomy: Abdomen

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The stomach receives its blood supply primarily from which of the following arteries:

a) Superior mesenteric artery ✗
b) Inferior mesenteric artery
c) Coeliac trunk ✓
d) Renal artery
e) Suprarenal artery

Answer

The arterial supply to the stomach is derived from all three branches (left gastric, splenic and common hepatic branches) of the coeliac trunk.

Notes

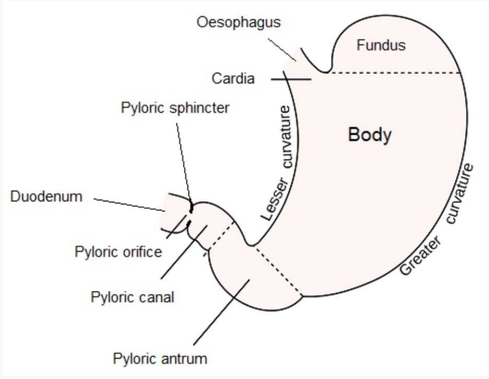
The stomach is the most dilated part of the gastrointestinal tract and has a J-like shape. The stomach is in the epigastric, umbilical and left hypochondriac regions of the abdomen. It is an intraperitoneal organ.

Anatomical distinctions

The stomach is divided into four regions:

- the cardia which surrounds the opening of the oesophagus into the stomach
- the fundus which is the area above the level of the cardiac orifice
- the body which is the largest central region of the stomach
- the pyloric part which is divided into the pyloric antrum and the pyloric canal which opens into the duodenum.

The most distal portion of the pyloric canal contains a thickened ring of gastric circular muscle, the pyloric sphincter that surrounds the distal pyloric orifice. The pyloric orifice is just to the right of the midline in the transpyloric plane. The pyloric sphincter controls the exit of chyme from the stomach into the duodenum. The sphincter is constricted by sympathetic stimulation and relaxed by parasympathetic action. Parasympathetic fibres in the vagus nerve are also secretomotor to gastric glands and motor to muscular wall of stomach.



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Relations

The stomach lies inferior to the diaphragm.

The stomach lies posterior to:

- the anterior abdominal wall
- the left costal margin
- the left lobe of the liver

The stomach lies anterior to the stomach bed formed by:

- the diaphragm
- the pancreas
- the transverse mesocolon
- the left colic flexure
- the left kidney
- the left adrenal gland
- the spleen

Blood supply

The arterial supply to the stomach is derived from all three branches (left gastric, splenic and common hepatic branches) of the coeliac trunk.

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Anatomy: Abdomen



Question 76 of 125

Regarding the inguinal canal, which of the following statements is CORRECT:

a The inguinal canal extends in a downwards and lateral direction.

b It lies just inferior and parallel to the inguinal ligament.

c It is about 8 cm long.

d The deep inguinal ring lies immediately lateral to the inferior epigastric vessels.

e The inferior epigastric vessels pass through the inguinal canal.

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Anatomy: Abdomen

Question 76 of 125

Regarding the inguinal canal, which of the following statements is CORRECT:

a) The inguinal canal extends in a downwards and lateral direction. ✗
b) It lies just inferior and parallel to the inguinal ligament.
c) It is about 8 cm long.
d) The deep inguinal ring lies immediately lateral to the inferior epigastric vessels. ✓
e) The inferior epigastric vessels pass through the inguinal canal.

Answer

The deep inguinal ring lies immediately lateral to the inferior epigastric vessels. The inguinal canal is a slit-like passage that extends in a downwards and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the deep inguinal ring and continues for approximately 4 cm, ending at the superficial inguinal ring.

Notes

Space	Inguinal canal
Position	Between deep and superficial inguinal rings, just above and parallel to lower half of inguinal ligament
Anterior wall	Formed by external oblique aponeurosis (reinforced by internal oblique muscle laterally)
Posterior wall	Formed by transversalis fascia (reinforced by conjoint tendon medially)
Roof	Formed by transversus abdominis and internal oblique muscles
Floor	Formed by medial one-half of inguinal ligament (reinforced by lacunar ligament medially)
Deep inguinal ring	Opening in transversalis fascia, located just superior to mid-inguinal point (midway between ASIS and pubic symphysis)
Superficial inguinal ring	Opening in external oblique aponeurosis, located just superior to pubic tubercle
Contents	Genital branch of genitofemoral nerve, spermatic cord, round ligament, ilioinguinal nerve

Position

The inguinal canal is a slit-like passage that extends in a downwards and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the deep inguinal ring and continues for approximately 4 cm, ending at the superficial inguinal ring.

Roof, walls and floor

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle, and reinforced by the internal oblique muscle laterally.

The posterior wall of the inguinal canal is formed along its entire length by the transversalis fascia and reinforced by the conjoint tendon medially.

The roof of the inguinal canal is formed by arching fibres of the transversus abdominis and internal oblique muscles.

The floor of the inguinal canal is formed by the medial one-half of the inguinal ligament, reinforced medially by the lacunar ligament.

Deep inguinal ring

The deep inguinal ring, the opening in the transversalis fascia, is the beginning of the inguinal canal.

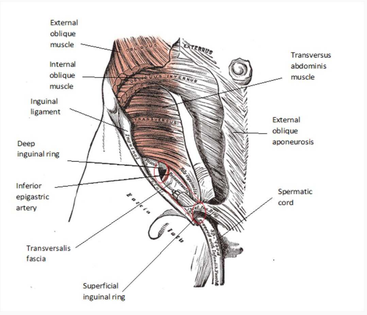
The deep inguinal ring is located just superior to a point midway between the anterior superior iliac spine and the pubic symphysis (the mid-inguinal point). N.B. Some sources state it is located at a slightly different site, just superior to a point midway between the anterior superior iliac spine and the pubic tubercle (the midpoint of the inguinal ligament).

It lies just above the inguinal ligament and immediately lateral to the inferior epigastric vessels; the femoral artery can be palpated in the same position but below the inguinal ligament.

Superficial inguinal ring

The superficial inguinal ring is the end of the inguinal canal.

The superficial inguinal ring is located just superior to the pubic tubercle. It is a triangular opening in the aponeurosis of the external oblique, with its apex pointing superolaterally and its base formed by the pubic crest.



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Contents

The inguinal canal contains:

- the genital branch of the genitofemoral nerve (within the spermatic cord in men)
- the spermatic cord in men
- the round ligament in women
- the ilioinguinal nerve (passes through part of the canal, exiting the superficial inguinal ring with the other contents)

Inguinal hernia

An inguinal hernia is the protrusion of a peritoneal sac through a weakened part of the abdominal wall in the groin.

Hernia	Indirect inguinal hernia	Direct inguinal hernia
Aetiology	Congenital – patent processus vaginalis	Acquired – weakened abdominal musculature
Mechanism	Peritoneal sac herniates through deep inguinal ring	Peritoneal sac herniates directly through posterior wall of inguinal canal
Relation to inferior epigastric vessels	Lateral to inferior epigastric vessels	Medial to inferior epigastric vessels

In indirect inguinal hernias, the most common type, the peritoneal sac enters the inguinal canal by passing through the deep inguinal ring, due to a patent embryonic processus vaginalis. If the entire processus vaginalis remains patent, the peritoneal sac may traverse the length of the canal, exit the superficial inguinal ring and continue into the scrotum or labia majora.

In direct inguinal hernias, the peritoneal sac passes directly through the posterior wall of the inguinal canal. It usually occurs when abdominal musculature has been weakened, in older men, following surgery or due to persistent raised intra-abdominal pressure. This type of hernia does not traverse the inguinal canal, but may still exit the superficial inguinal ring to enter the scrotum.

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Anatomy: Abdomen



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The roof of the inguinal canal is formed primarily by which of the following structures:

a Transversus abdominis and internal oblique muscles

b External oblique muscle

c External oblique aponeurosis

d Transversalis fascia

e Rectus abdominis muscle

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Anatomy: Abdomen

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a) Transversus abdominis and internal oblique muscles ✔
b) External oblique muscle
c) External oblique aponeurosis
d) Transversalis fascia
e) Rectus abdominis muscle

Answer

The roof of the inguinal canal is formed by arching fibres of the transversus abdominis and internal oblique muscles.

Notes

Space	Inguinal canal
Position	Between deep and superficial inguinal rings, just above and parallel to lower half of inguinal ligament
Anterior wall	Formed by external oblique aponeurosis (reinforced by internal oblique muscle laterally)
Posterior wall	Formed by transversalis fascia (reinforced by conjoint tendon medially)
Roof	Formed by transversus abdominis and internal oblique muscles
Floor	Formed by medial one-half of inguinal ligament (reinforced by lacunar ligament medially)
Deep inguinal ring	Opening in transversalis fascia, located just superior to mid-inguinal point (midway between ASIS and pubic symphysis)
Superficial inguinal ring	Opening in external oblique aponeurosis, located just superior to pubic tubercle
Contents	Genital branch of genitofemoral nerve, spermatic cord, round ligament, ilioinguinal nerve

Position

The inguinal canal is a slit-like passage that extends in a downwards and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the deep inguinal ring and continues for approximately 4 cm, ending at the superficial inguinal ring.

Roof, walls and floor

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle, and reinforced by the internal oblique muscle laterally.

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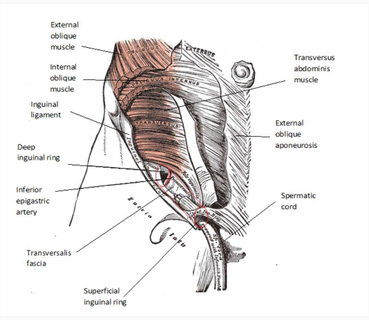
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Anatomy: Abdomen



Question 78 of 125

The blood supply to the pancreas is primarily from which of the following arteries:

a Left gastric artery

b Common hepatic artery

c Splenic artery

d Superior mesenteric artery

e Inferior mesenteric artery

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Anatomy: Abdomen

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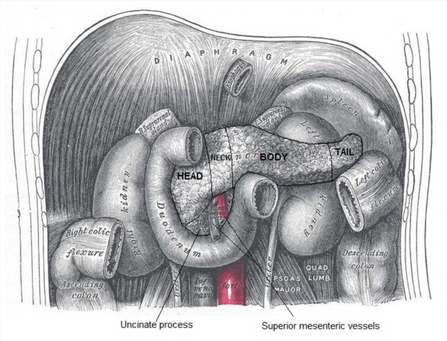
a) **Left gastric artery** ✗
b) Common hepatic artery
c) Splenic artery ✓
d) Superior mesenteric artery
e) Inferior mesenteric artery

Answer

The arterial supply to the pancreas is primarily derived from the splenic artery from the coeliac trunk, assisted by pancreaticoduodenal branches from the gastroduodenal artery (from the common hepatic artery from the coeliac trunk), and from the superior mesenteric artery.

Notes

The pancreas lies mostly posterior to the stomach. It extends across the posterior abdominal wall from the duodenum on the right, to the spleen on the left. It lies in the epigastric region and left hypochondrium. The pancreas is a retroperitoneal organ (except for a small part of its tail) and consists of a head, uncinate process, neck, body and tail.

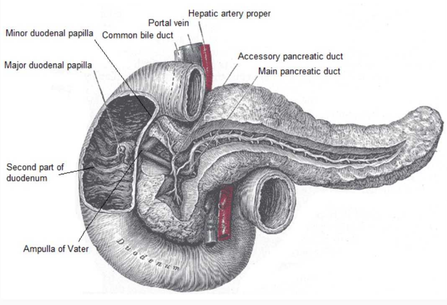


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Relations

- The head of the pancreas lies within the C-shaped concavity of the duodenum. The head is related anteriorly to the first part of the duodenum, the transverse colon and coils of jejunum and posteriorly to the common bile duct and the inferior vena cava and the termination of the renal veins.
- The uncinate process projects from the lower part of the head and passes posterior to the superior mesenteric vessels.
- The neck is anterior to the superior mesenteric vessels. Posterior to the neck of the pancreas, the superior mesenteric and splenic veins join to form the portal vein.
- The body is elongated and extends from the neck to the tail of the pancreas in the transpyloric plane (at the level of vertebra L1) to lie behind the stomach and to the left of the superior mesenteric vessels.
- The intraperitoneal tail passes between layers of the splenorenal ligament. It is related to the left kidney posteriorly, the hilum of the spleen laterally, the left colic flexure inferiorly and the stomach anteriorly.

The pancreatic duct begins in the tail of the pancreas and passes to the right, through the body and to the head where it turns inferiorly and joins the bile duct forming the hepatopancreatic ampulla (ampulla of Vater) which enters the second part of the duodenum at the major duodenal papilla. The accessory pancreatic duct empties into the duodenum just above the major duodenal papilla at the minor duodenal papilla.



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Blood supply

The arterial supply to the pancreas is primarily derived from the splenic artery from the coeliac trunk, assisted by branches from the gastroduodenal artery (from the common hepatic artery from the coeliac trunk), and from the superior mesenteric artery.

Venous drainage of the head of the pancreas is via pancreaticoduodenal veins into the superior mesenteric vein and portal vein. Venous drainage of the body and tail of the pancreas is via pancreatic veins into the splenic vein.

Lymphatics

Lymphatics draining the pancreas empty into the pancreaticosplenic nodes and the pyloric nodes, which in turn drain into the superior mesenteric and celiac pre-aortic lymph nodes.

Innervation

Visceral afferent fibres travel in the greater and lesser splanchnic nerves. The segmental level of innervation is T6 – T10. Pain typically radiates to the middle of the back due to irritation of the parietal peritoneum covering the pancreas.

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Anatomy: Abdomen



Question 79 of 125

The third part of the duodenum lies at which of the following vertebral levels:

a T12

b L1

c L2

d L3

e L4

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Anatomy: Abdomen

Question 79 of 125

The third part of the duodenum lies at which of the following vertebral levels:

a) T12
b) L1
c) L2
d) L3 ✔
e) L4

Answer

The inferior (third) part is the longest section, crossing the inferior vena cava, the aorta and the vertebral column at the level of vertebra L3 and lying inferior to the pancreas.

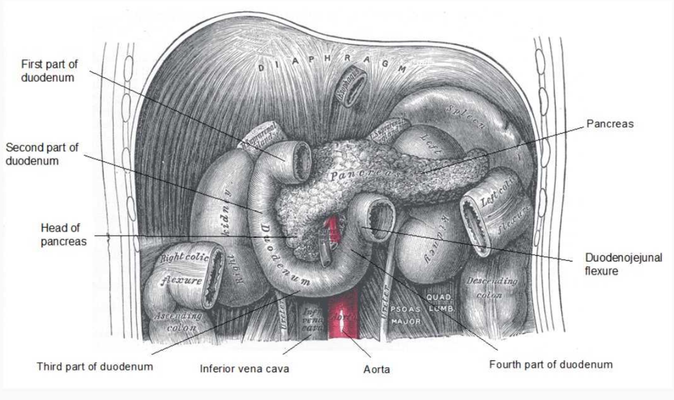
Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum. The first part of the small intestine is the duodenum.

The duodenum is a C-shaped structure, adjacent to the head of the pancreas, and above the level of the umbilicus. It is retroperitoneal except for its proximal part which is connected to the liver by the hepatoduodenal ligament of the lesser omentum.

Parts of the duodenum

- The superior (first) part extends from the pyloric orifice of the stomach to the neck of the gallbladder, lies just to the right of the body of vertebra L1, and passes anterior to the inferior vena cava and superior to the head of the pancreas.
- The descending (second) part is just to the right of the midline, extending from the neck of the gallbladder to the lower border of vertebra L3 and lying lateral to the head of the pancreas. This part contains the major duodenal papilla which is the common entrance for the bile and pancreatic ducts.
- The inferior (third) part is the longest section, crossing the inferior vena cava, the aorta and the vertebral column at the level of vertebra L3 and lying inferior to the pancreas.
- The ascending (fourth) part passes upwards on, or to the left of the aorta to approximately the upper border of vertebra L2 and terminates at the duodenojejunal flexure.



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Blood supply

The arterial supply of the duodenum is primarily from the pancreaticoduodenal arteries, branches of the superior mesenteric artery and the gastroduodenal artery (branch of the common hepatic artery from the coeliac trunk).

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Anatomy: Abdomen

Question 80 of 125



Which of the following best describes the attachment of the base of the appendix:

a Lateral wall of caecum inferior to ileocaecal valve

b Medial wall of ascending colon, superior to ileocaecal valve

c Antimesenteric border of ileum just proximal to ileocaecal valve

d Posteromedial wall of caecum inferior to ileocaecal valve

e Medial wall of caecum superior to ileocaecal valve

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Anatomy: Abdomen

Question 80 of 125

Which of the following best describes the attachment of the base of the appendix:

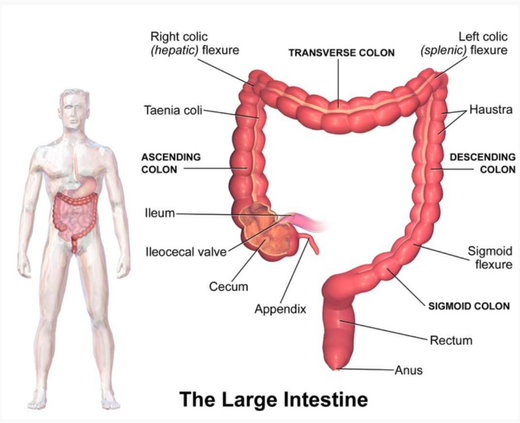
a) **Lateral wall of caecum inferior to ileocaecal valve** ✗
b) Medial wall of ascending colon, superior to ileocaecal valve
c) Antimesenteric border of ileum just proximal to ileocaecal valve
d) Posteromedial wall of caecum inferior to ileocaecal valve ✓
e) Medial wall of caecum superior to ileocaecal valve

Answer

The appendix is attached to the posteromedial wall of the caecum, just inferior to the end of the ileum. Its point of attachment to the caecum is consistent with the highly visible free taeniae leading directly to the base of the appendix but the rest of its location is highly variable.

Notes

The large intestine extends from the distal end of the ileum to the anus, and comprises the caecum, appendix, colon, rectum and anal canal.



Blausen.com staff. "Blausen gallery 2014". Wikiversity Journal of Medicine. DOI:10.15347/wjm/2014.010. ISSN 20018762. (Own work) [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons

Caecum

The intraperitoneal caecum is the first part of the large intestine. It is inferior to the ileocaecal opening and lies in the right iliac fossa. The caecum is continuous with the ascending colon at the entrance of the ileum and is usually in contact with the anterior abdominal wall. It may cross the pelvic brim to lie in the true pelvis.

Appendix

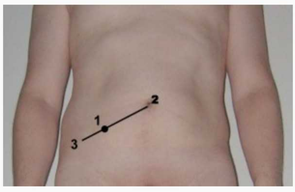
The appendix is attached to the posteromedial wall of the caecum, just inferior to the end of the ileum. The appendix is a narrow, hollow, blind-ended tube. It has large aggregations of lymphoid tissue in its walls and is suspended from the terminal ileum by the mesoappendix.

Its point of attachment to the caecum is consistent with the highly visible free taeniae leading directly to the base of the appendix but the rest of its location is highly variable. It may be:

- 1) posterior to the caecum or the lower ascending colon, or both, in a retrocaecal or retrocolic position
- 2) suspended over the pelvic brim in a pelvic or descending position
- 3) below the caecum in a subcaecal position
- 4) anterior to the terminal ileum, possibly contacting with the body wall in a pre-ileal position or posterior to the terminal ileum in a post-ileal position.

The most common position is retrocaecal, followed by pelvic. The retrocaecal appendix is related anteriorly to the caecum and posteriorly to the psoas major and iliacus muscle. The psoas sign may be positive in retrocaecal appendicitis. Irritation of the psoas muscle (hip flexor) gives rise to pain when the patient's right thigh is extended from a flexed position as the muscle is stretched.

The surface projection of the base of the appendix is at the junction of the lateral and middle one-third of a line from the anterior superior iliac spine to the umbilicus (McBurney's point). People with appendicitis may describe pain at this location.



(1 = McBurney's point, 2 = Umbilicus, 3 = ASIS) By Steven Fruitsmaak [GFDL (http://www.gnu.org/copyleft/fdl.html) or CC-BY-SA-3.0 (http://creativecommons.org/licenses/by-sa/3.0/)], via Wikimedia Commons

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Anatomy: Abdomen



Question 81 of 125

The jejunum predominantly occupies which region of the abdomen:

a Left upper quadrant

b Right upper quadrant

c Left lower quadrant

d Right lower quadrant

e Suprapubic region

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Anatomy: Abdomen

Question 81 of 125

The jejunum predominantly occupies which region of the abdomen:

a) **Left upper quadrant** ✔
b) Right upper quadrant
c) Left lower quadrant
d) Right lower quadrant
e) Suprapubic region

Answer

The jejunum is mostly in the left upper quadrant of the abdomen.

Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum.

The jejunum and ileum make up the last two sections of the small intestine.

The jejunum and ileum are intraperitoneal, attached to the posterior abdominal wall by the mesentery.

Jejunum

The jejunum represents the proximal two-fifths. It is mostly in the left upper quadrant of the abdomen and is larger in diameter and has a thicker wall than the ileum.

Ileum

The ileum makes up the distal three-fifths and is mostly in the right lower quadrant. The ileum invaginates into the large intestine at the ileocaecal junction forming the ileocaecal valve, which prevents reflux from the caecum to the ileum and regulates the passage of contents from the ileum to the caecum.

Blood supply

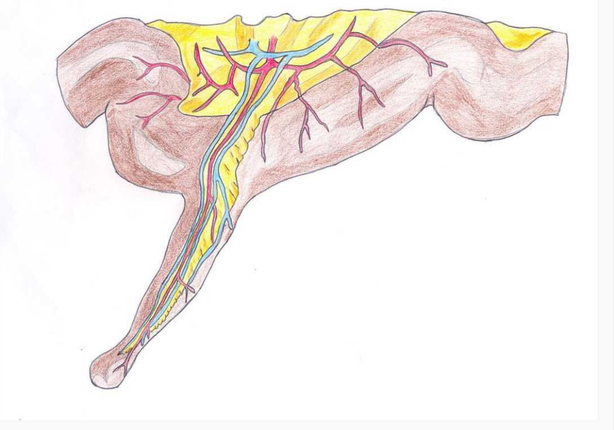
The arterial supply to the jejunum and ileum is derived from the superior mesenteric artery.

Innervation

The sympathetic nerve supply is derived from the T9 – T10 spinal cord segments. Pain from the small jejunum and ileum is referred to the peri-umbilical region.

Meckel's diverticulum

A Meckel's diverticulum is the remnant of the proximal part of the yolk stalk (vitelline duct) that extends into the umbilical cord in the embryo and lies on the antimesenteric border of the ileum, approximately **2 feet** proximal to the ileocaecal junction. It appears as a blind-ended tubular outpouching of bowel, about **2 inches** long, occurring in about **2%** of the population, and may contain **two types** of ectopic tissue (gastric and pancreatic). Complications include haemorrhage, intussusception, diverticulitis, ulceration and obstruction, and symptoms may mimic those of acute appendicitis.



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Anatomy: Abdomen



Question 82 of 125

Which of the following is the functional unit of the liver:

a Hepatocyte

b Lobule

c Portal triad

d Lobe

e Acinus

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Anatomy: Abdomen

Question 82 of 125

Which of the following is the functional unit of the liver:

a) Hepatocyte ✗
b) Lobule ✓
c) Portal triad
d) Lobe
e) Acinus

Answer

Microscopically, hepatocytes are arranged into lobules which are the functional units of the liver. Each lobule is hexagonal-shaped, and is drained by a venule in its centre called a central vein (which drains to the hepatic vein). At the periphery of the hexagonal liver lobules are three structures collectively known as the portal triad, comprising a portal arteriole (a branch of the hepatic artery), a portal venule (a branch of the hepatic portal vein) and a bile duct. The portal triad also contains lymphatic vessels and vagal parasympathetic nerve fibres.

Notes

The liver is the largest visceral organ in the body and is primarily located in the right hypochondrium and epigastric region, extending into the left hypochondrium.

Surface marking

Most of the liver is under the right dome of the diaphragm and deep to the lower thoracic wall. The inferior margin of the liver can be palpated descending below the right costal margin on deep inspiration.

The inferior margin is indicated by a line that joins points at the right tenth costal cartilage in the midaxillary line, the tip of the right ninth costal cartilage, the transpyloric plane in the midline, the tip of the left eighth costal cartilage and the left fifth rib in the midclavicular line.

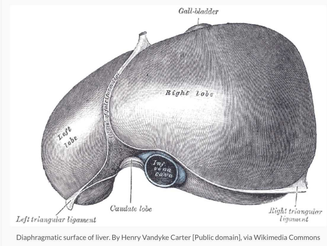
The superior margin is indicated by a line that joints a point on the left fifth rib at the midclavicular line to a corresponding point on the right side. The superior margin is concave in its central part and crosses behind the xiphisternal joint.

Anatomical surfaces

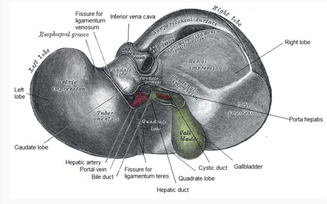
The liver has a diaphragmatic surface in the anterior, superior, and posterior directions and a visceral surface in the inferior direction.

The diaphragmatic surface of the liver is related anteriorly to the anterior abdominal wall and rib cage and superiorly to the diaphragm.

The visceral surface of the liver is related to the oesophagus, right anterior part of the stomach, superior part of the duodenum, lesser omentum, gallbladder, right colic flexure, right transverse colon, right kidney and right adrenal gland.



Diaphragmatic surface of liver. By Henry Vandyke Carter [Public domain], via Wikimedia Commons



Inferior surface of liver. Modified by FRCEM Success. Original by Henry Vandyke Carter [Public domain], via Wikimedia Commons

Lobes

There are four anatomical lobes to the liver.

- The liver is divided into the left and right lobe by the fossae for the gallbladder and the inferior vena cava.
- The caudate lobe sits between the fissure for the ligamentum venosum and the inferior vena cava.
- The quadrate lobe is located between the gallbladder and the fissure for the ligamentum teres.

The porta hepatis is the central intraperitoneal fissure of the liver that separates the caudate and the quadrate lobes. The porta hepatis serves as the point of entry into the liver for the hepatic arteries and portal vein, and the exit point for the hepatic ducts.

Liver lobules

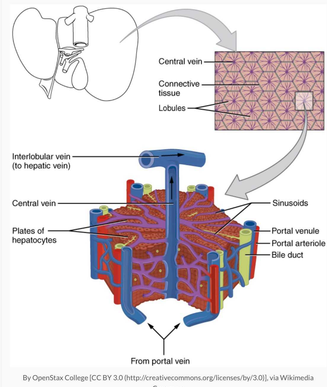
Microscopically, hepatocytes are arranged into lobules which are the functional units of the liver. Each lobule is hexagonal-shaped, and is drained by a venule in its centre, called a central vein (which drains to the hepatic vein).

At the periphery of the hexagon are three structures collectively known as the portal triad, comprising:

- a portal arteriole (a branch of the hepatic artery),
- a portal venule (a branch of the hepatic portal vein),
- a bile duct.

The portal triad also contains lymphatic vessels and vagal parasympathetic nerve fibres.

The liver sinusoids serve as a location for mixing of the oxygen-rich blood from the hepatic artery and the nutrient-rich blood from the portal vein.



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Blood supply

The liver has a unique dual blood supply. The arterial supply to the liver is from the left and right hepatic arteries derived from the hepatic artery proper, a branch of the common hepatic artery from the coeliac trunk.

The hepatic portal vein (formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2) supplies the liver with deoxygenated blood carrying nutrients absorbed from the small intestine.

Venous drainage of the liver is achieved through three hepatic veins, which return the venous blood to the inferior vena cava just inferior to the diaphragm.

Lymphatic drainage

The lymphatic vessels of the liver drain into hepatic lymph nodes which empty in the coeliac lymph nodes.

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Anatomy: Abdomen



Question 83 of 125

The common bile duct is formed from which of the following structures:

a The right and left hepatic duct

b The common hepatic duct and the pancreatic duct

c The common hepatic duct and the cystic duct

d The cystic duct and the pancreatic duct

e The hepatic ducts and hepatic artery proper

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Anatomy: Abdomen

Question 83 of 125

The common bile duct is formed from which of the following structures:

a) **The right and left hepatic duct** ✖
b) The common hepatic duct and the pancreatic duct
c) The common hepatic duct and the cystic duct ✔
d) The cystic duct and the pancreatic duct
e) The hepatic ducts and hepatic artery proper

Answer

The common hepatic duct and the cystic duct combine to form the common bile duct.

Notes

Biliary tree

The biliary tree begins in the liver parenchyma with the formation of the left and right hepatic duct which drain bile from the liver where it has been synthesised. These two ducts meet to form the common hepatic duct which runs near the liver, with the hepatic artery proper and portal vein in the free margin of the lesser omentum.

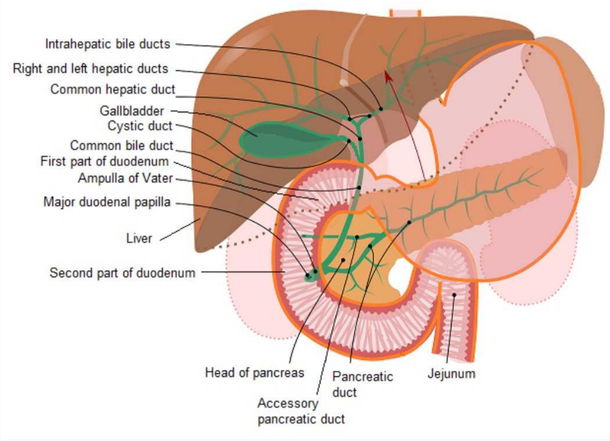
As the common hepatic duct descends, it is joined by the cystic duct, which is a continuation of the neck of the gallbladder. The common hepatic duct and the cystic duct combine to form the common bile duct. At this point the bile duct lies to the right of the hepatic artery proper and usually to the right of, and anterior to, the portal vein in the free margin of the lesser omentum.

As the common bile duct descends, it passes posterior to the first part of the duodenum before joining with the pancreatic duct from the pancreas, forming the hepatopancreatic ampulla (ampulla of Vater) at the major duodenal papilla, located in the second part of the duodenum. Surrounding the ampulla is the sphincter of Oddi, a collection of smooth muscle which can open to allow bile and pancreatic fluid to empty into the duodenum.

Common bile duct relations

The common bile duct can be divided into three main regions, based on its relation to the duodenum:

- The first supraduodenal region is the upper one-third which lies in the free margin of the lesser omentum with the hepatic artery and portal vein. The common bile duct lies anterior to the portal vein and to the right of the hepatic artery proper.
- The second retroduodenal region is the middle one-third which lies posterior to the first part of the duodenum. The gastroduodenal artery lies on its left aspect and the portal vein on its posterior aspect.
- The third infraduodenal region is the lower one-third which lies in a groove on the posterior surface of the head of the pancreas, to the left of the second part of the duodenum and anterior to the right renal vein and inferior vena cava.



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Anatomy: Abdomen



Question 84 of 125

Which of the following structures is not related to the visceral surface of the liver:

a Right kidney

b Superior part of the duodenum

c Oesophagus

d Lesser omentum

e Spleen

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Anatomy: Abdomen

Question 84 of 125

Which of the following structures is not related to the visceral surface of the liver:

a) **Right kidney** ✘
b) Superior part of the duodenum
c) Oesophagus
d) Lesser omentum
e) Spleen ✔

Answer

The visceral surface of the liver is related to the oesophagus, right anterior part of the stomach, superior part of the duodenum, lesser omentum, gallbladder, right colic flexure, right transverse colon, right kidney and right adrenal gland.

Notes

The liver is the largest visceral organ in the body and is primarily located in the right hypochondrium and epigastric region, extending into the left hypochondrium.

Surface marking

Most of the liver is under the right dome of the diaphragm and deep to the lower thoracic wall. The inferior margin of the liver can be palpated descending below the right costal margin on deep inspiration.

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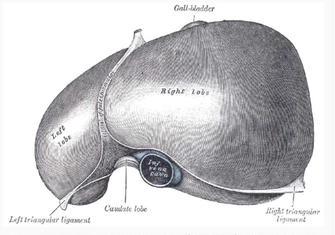
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Anatomical surfaces

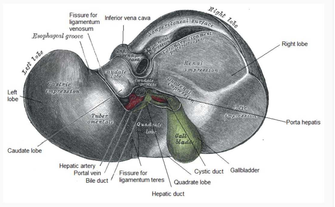
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Diaphragmatic surface of liver. By Henry Vandyke Carter [Public domain], via Wikimedia Commons



Inferior surface of liver. Modified by FRCEM Success. Original by Henry Vandyke Carter [Public domain], via Wikimedia Commons

Lobes

There are four anatomical lobes to the liver.

- The liver is divided into the left and right lobe by the fossae for the gallbladder and the inferior vena cava.
- The caudate lobe sits between the fissure for the ligamentum venosum and the inferior vena cava.
- The quadrate lobe is located between the gallbladder and the fissure for the ligamentum teres.

The porta hepatis is the central intraperitoneal fissure of the liver that separates the caudate and the quadrate lobes. The porta hepatis serves as the point of entry into the liver for the hepatic arteries and portal vein, and the exit point for the hepatic ducts.

Liver lobules

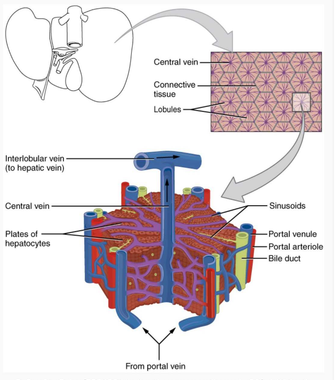
Microscopically, hepatocytes are arranged into lobules which are the functional units of the liver. Each lobule is hexagonal-shaped, and is drained by a venule in its centre, called a central vein (which drains to the hepatic vein).

At the periphery of the hexagon are three structures collectively known as the portal triad, comprising:

- a portal arteriole (a branch of the hepatic artery),
- a portal venule (a branch of the hepatic portal vein),
- a bile duct.

The portal triad also contains lymphatic vessels and vagal parasympathetic nerve fibres.

The liver sinusoids serve as a location for mixing of the oxygen-rich blood from the hepatic artery and the nutrient-rich blood from the portal vein.



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Blood supply

The liver has a unique dual blood supply. The arterial supply to the liver is from the left and right hepatic arteries derived from the hepatic artery proper, a branch of the common hepatic artery from the coeliac trunk.

The hepatic portal vein (formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2) supplies the liver with deoxygenated blood carrying nutrients absorbed from the small intestine.

Venous drainage of the liver is achieved through three hepatic veins, which return the venous blood to the inferior vena cava just inferior to the diaphragm.

Lymphatic drainage

The lymphatic vessels of the liver drain into hepatic lymph nodes which empty in the coeliac lymph nodes.

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Anatomy: Abdomen



Question 85 of 125

The inguinal ligament is formed from which of the following:

a The lower free border of the external oblique aponeurosis

b The lower free border of the internal oblique aponeurosis

c The lower free border of the transversus abdominis aponeurosis

d The lower free border of the rectus abdominis aponeurosis

e The lower free border of the thoracolumbar fascia

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Anatomy: Abdomen

Question 85 of 125

The inguinal ligament is formed from which of the following:

a) The lower free border of the external oblique aponeurosis ✔
b) The lower free border of the internal oblique aponeurosis
c) The lower free border of the transversus abdominis aponeurosis
d) The lower free border of the rectus abdominis aponeurosis
e) The lower free border of the thoracolumbar fascia

Answer

The lower free border of the external oblique aponeurosis forms the inguinal ligament on each side (which runs between the anterior superior iliac spine laterally and the pubic tubercle medially).

Notes

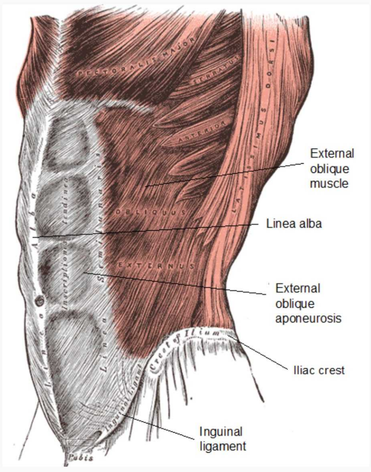
There are five muscles in the anterolateral group of abdominal wall muscles; three flat muscles whose fibres begin posterolaterally and pass anteriorly before being replaced by an aponeurosis as the muscle continues towards the midline (external oblique, internal oblique, transversus abdominis) and two vertical muscles enclosed by the tendinous sheath formed by the aponeuroses of the flat muscles (rectus abdominis, pyramidalis).

External oblique

The external oblique is the largest and most superficial of the anterior abdominal muscles, lying just deep to the superficial fascia. The external oblique originates from the outer surfaces of the lower eight ribs, its fibres running in an inferomedial direction before inserting onto the lateral lip of the iliac crest.

The external oblique has a large aponeurotic component that covers the anterior part of the abdominal wall and forms the linea alba at the midline, together with the aponeuroses from the internal oblique and the transversus abdominis. The linea alba extends from the xiphoid process to the pubic symphysis.

The lower free border of the external oblique aponeurosis forms the inguinal ligament on each side (which runs between the anterior superior iliac spine laterally and the pubic tubercle medially).



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Internal oblique

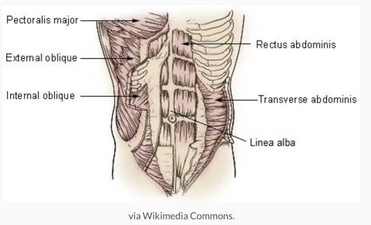
The internal oblique muscle lies deep to the external oblique. Its fibres run in a superomedial direction, originating from the thoracolumbar fascia, the iliac crest and the lateral two-thirds of the inguinal ligament and inserting onto the inferior border of the lower 3 – 4 ribs, the linea alba, the pubic crest and pectineal line.

Transversus abdominis

The transversus abdominis is the innermost of the flat anterior abdominal muscles, lying deep to the internal oblique. It originates from the thoracolumbar fascia, the iliac crest, the lateral one-third of the inguinal ligament and the 7th – 12th costal cartilages and inserts onto the linea alba, the pubic crest and the pectineal line.

Rectus abdominis

The rectus abdominis is a long muscle that extends the length of the anterior abdominal wall. It originates from the pubic crest, pubic tubercle and pubic symphysis and inserts onto the costal cartilages of ribs 5 – 7 and to the xiphoid process. It is a paired muscle, separated in the midline by the linea alba.



via Wikimedia Commons.

Function

The abdominal wall muscles form a firm, but flexible wall that keeps the abdominal viscera within the abdominal cavity, protects the viscera from injury and helps maintain the position of the viscera in the erect posture against the action of gravity.

The muscles act together to flex and rotate the vertebral column.

In addition, contraction of these muscles assists in forced expiration, and in coughing and vomiting, by pushing the viscera upwards. All of these muscles are involved in any action that increases intra-abdominal pressure, including childbirth, micturition and defaecation.

Innervation

The anterior abdominal wall muscles are innervated by the anterior rami of T7 – T12 and L1.

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Anatomy: Abdomen



Question 86 of 125

Regarding the large intestine, which of the following parts is not described correctly:

a Caecum – Intraperitoneal

b Ascending colon – Retroperitoneal

c Transverse colon – Intraperitoneal

d Descending colon – Retroperitoneal

e Sigmoid colon – Retroperitoneal

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Anatomy: Abdomen

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Regarding the large intestine, which of the following parts is not described correctly:

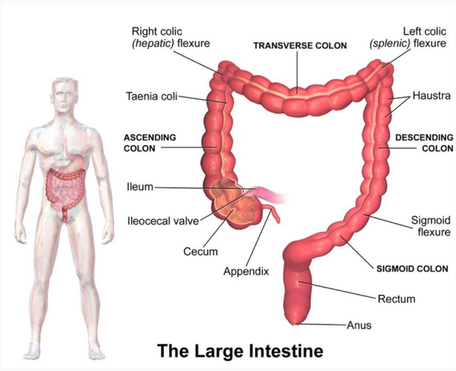
a) **Caecum – Intraperitoneal** ✖
b) Ascending colon – Retroperitoneal
c) Transverse colon – Intraperitoneal
d) Descending colon – Retroperitoneal
e) Sigmoid colon – Retroperitoneal ✔

Answer

The ascending and descending colon are retroperitoneal. The caecum, transverse colon and sigmoid colon are intraperitoneal.

Notes

The large intestine extends from the distal end of the ileum to the anus, and comprises the caecum, appendix, colon, rectum and anal canal.



Blausen.com staff. "Blausen gallery 2014". Wikiversity Journal of Medicine. DOI:10.15347/wjm/2014.010. ISSN 20018762. (Own work) [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons

Colon

The colon continues from the caecum in the right groin as the ascending colon, which passes upwards through the right flank and into the right hypochondrium.

Just below the right lobe of the liver, it bends to the left forming the right colic flexure (hepatic flexure), and crosses the abdomen as the transverse colon to the left hypochondrium. The transverse colon is related superiorly to the liver, gallbladder, greater curvature of the stomach and the lateral end of the spleen.

At this point, just below the spleen, it bends downwards forming the left colic flexure (splenic flexure) and continues as the descending colon through the left flank and into the left groin. The splenic flexure is higher and more posterior than the hepatic flexure, and is attached to the diaphragm by the phrenicocolic ligament.

The colon enters the upper part of the pelvis as the sigmoid colon, which begins above the pelvic inlet and extends to the level of vertebra S3 where it is continuous with the rectum. This S-shaped structure is quite mobile except at its proximal and distal end which are attached to the descending colon and rectum respectively. Between these points, it is suspended by the sigmoid mesocolon.

The ascending and descending segments are retroperitoneal and the transverse and sigmoid segments are intraperitoneal.

Relations

Colon	Anterior relations	Posterior relations
Ascending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, right kidney
Transverse colon	Liver, gallbladder, stomach, greater omentum, anterior abdominal wall	Second part of duodenum, head of pancreas, upper end of mesentery, duodenojejunal flexure, coils of jejunum and ileum
Descending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, left kidney
Sigmoid colon	Bladder, uterus and upper vagina	Rectum, sacrum, ileum

Blood supply

The arterial supply to the colon is derived from the superior mesenteric artery (caecum, appendix, ascending colon, hepatic flexure, proximal two-thirds of transverse colon) and the inferior mesenteric artery (distal one-thirds of transverse colon, splenic flexure, descending colon, sigmoid colon).

As the terminal vessels of the superior mesenteric and inferior mesenteric artery approach the colon they split into many colic branches which anastomose with each other. These anastomoses from a continuous arterial channel which extends the length of the colon, the marginal artery.

At the junctional area of the supply of the superior and inferior mesenteric arteries, the anastomosis may not be sufficient, thus the splenic flexure is most susceptible to ischaemia.

Innervation

The visceral pain sensation from the ascending and transverse colon travels through the lesser splanchnic nerve to the T10 – T11 spinal cord segments hence pain is referred to the umbilical and hypogastric regions.

Pain from the descending and sigmoid colon is carried in the lumbar splanchnic nerves to the L1 and L2 spinal cord segments hence pain is referred to the inguinal region and thigh.

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Anatomy: Abdomen



Question 87 of 125

A 45 year old overweight female, with known gallstones presents to ED complaining of severe right upper quadrant pain. Imaging shows that large gallstones have eroded through the posterior wall of the fundus of the gallbladder to enter the intestine. Which of the following parts of the intestine is most likely to first contain gallstones:

a Caecum

b Ascending colon

c Transverse colon

d Descending colon

e Sigmoid colon

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Anatomy: Abdomen

Question 87 of 125

A 45 year old overweight female, with known gallstones presents to ED complaining of severe right upper quadrant pain. Imaging shows that large gallstones have eroded through the posterior wall of the fundus of the gallbladder to enter the intestine. Which of the following parts of the intestine is most likely to first contain gallstones:

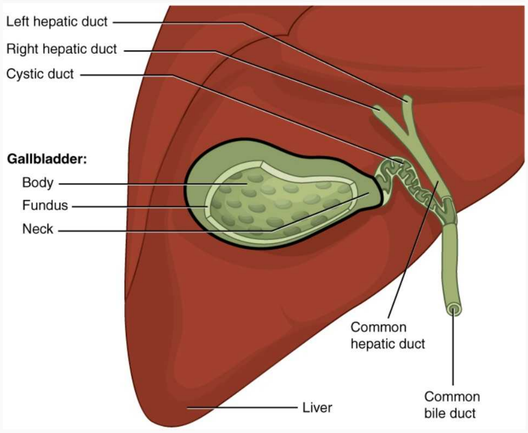
a) Caecum ✗
b) Ascending colon
c) Transverse colon ✓
d) Descending colon
e) Sigmoid colon

Answer

The fundus of the gallbladder lies anterior to and in contact with the transverse colon, thus gallstones eroding through the posterior wall of fundus of the gallbladder will enter the right transverse colon (and then pass naturally through the descending colon and sigmoid colon). Gallstones lodged in the body of the gallbladder may ulcerate through the posterior wall of the body to enter the duodenum (and may then become lodged at the ileocaecal junction causing intestinal obstruction).

Notes

The gallbladder is a pear-shaped sac lying on the visceral surface of the right lobe of the liver in a fossa between the right and quadrate lobes. It is an intraperitoneal structure and lies in the right hypochondrium. It is located at the junction of the right ninth costal cartilage and the lateral border of the rectus abdominis muscle which is the site of maximal tenderness in the acute inflammation of the gallbladder.



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Structure

It has:

- a rounded end, the fundus, which may project from the inferior border of the liver
- a major part in the fossa, the body, which may lie against the transverse colon and the superior part of the duodenum
- and a narrow part, the neck, which tapers to become continuous with the cystic duct.

The neck contains a mucosal fold, known as Hartmann's pouch, which is a common site for gallstones to become lodged.

Relations

The gallbladder lies:

- posterior and inferior to the liver
- posterior to the anterior abdominal wall
- anterior to the transverse colon and the proximal duodenum
- superior to the biliary tree and the duodenum.

Innervation

Inflammation of the gallbladder may present with pain in the right upper quadrant and also the right shoulder; this is due to irritation of the diaphragmatic visceral peritoneum innervated by the phrenic nerve (C3 – C5) that also innervate skin over the shoulder.

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Anatomy: Abdomen



Question 88 of 125

Regarding the transversus abdominis muscle, which of the following statements is CORRECT:

a It lies deep to the rectus abdominis muscle.

b It originates from the medial half of the inguinal ligament and the iliac crest.

c It inserts onto the linea alba and the pubic crest.

d It is intersected along its length by tendinous intersections.

e The lower free border of its aponeurosis forms the inguinal ligament

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Anatomy: Abdomen

Question 88 of 125

Regarding the transversus abdominis muscle, which of the following statements is CORRECT:

a) **It lies deep to the rectus abdominis muscle.** ✖
b) It originates from the medial half of the inguinal ligament and the iliac crest.
c) It inserts onto the linea alba and the pubic crest. ✔
d) It is intersected along its length by tendinous intersections.
e) The lower free border of its aponeurosis forms the inguinal ligament

Answer

The transversus abdominis is the innermost of the flat anterior abdominal muscles, lying deep to the internal oblique. It originates from the thoracolumbar fascia, the iliac crest, the lateral one-third of the inguinal ligament and the 7th – 12th costal cartilages and inserts onto the linea alba, the pubic crest and the pectineal line. The rectus abdominis muscle is intersected by tendinous intersections. The inguinal ligament is formed from the lower free border of the external oblique aponeurosis.

Notes

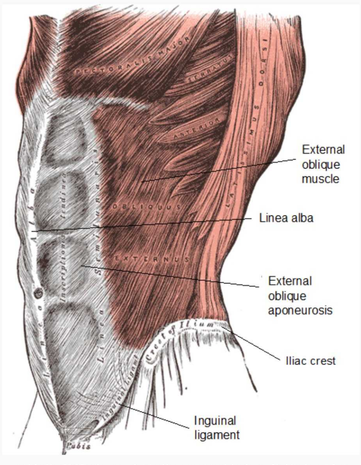
There are five muscles in the anterolateral group of abdominal wall muscles; three flat muscles whose fibres begin posterolaterally and pass anteriorly before being replaced by an aponeurosis as the muscle continues towards the midline (external oblique, internal oblique, transversus abdominis) and two vertical muscles enclosed by the tendinous sheath formed by the aponeuroses of the flat muscles (rectus abdominis, pyramidalis).

External oblique

The external oblique is the largest and most superficial of the anterior abdominal muscles, lying just deep to the superficial fascia. The external oblique originates from the outer surfaces of the lower eight ribs, its fibres running in an inferomedial direction before inserting onto the lateral lip of the iliac crest.

The external oblique has a large aponeurotic component that covers the anterior part of the abdominal wall and forms the linea alba at the midline, together with the aponeuroses from the internal oblique and the transversus abdominis. The linea alba extends from the xiphoid process to the pubic symphysis.

The lower free border of the external oblique aponeurosis forms the inguinal ligament on each side (which runs between the anterior superior iliac spine laterally and the pubic tubercle medially).



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Internal oblique

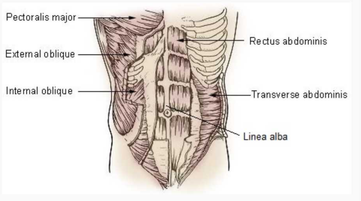
The internal oblique muscle lies deep to the external oblique. Its fibres run in a superomedial direction, originating from the thoracolumbar fascia, the iliac crest and the lateral two-thirds of the inguinal ligament and inserting onto the inferior border of the lower 3 – 4 ribs, the linea alba, the pubic crest and pectineal line.

Transversus abdominis

The transversus abdominis is the innermost of the flat anterior abdominal muscles, lying deep to the internal oblique. It originates from the thoracolumbar fascia, the iliac crest, the lateral one-third of the inguinal ligament and the 7th – 12th costal cartilages and inserts onto the linea alba, the pubic crest and the pectineal line.

Rectus abdominis

The rectus abdominis is a long muscle that extends the length of the anterior abdominal wall. It originates from the pubic crest, pubic tubercle and pubic symphysis and inserts onto the costal cartilages of ribs 5 – 7 and to the xiphoid process. It is a paired muscle, separated in the midline by the linea alba.



via Wikimedia Commons.

Function

The abdominal wall muscles form a firm, but flexible wall that keeps the abdominal viscera within the abdominal cavity, protects the viscera from injury and helps maintain the position of the viscera in the erect posture against the action of gravity.

The muscles act together to flex and rotate the vertebral column.

In addition, contraction of these muscles assists in forced expiration, and in coughing and vomiting, by pushing the viscera upwards. All of these muscles are involved in any action that increases intra-abdominal pressure, including childbirth, micturition and defaecation.

Innervation

The anterior abdominal wall muscles are innervated by the anterior rami of T7 – T12 and L1.

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Anatomy: Abdomen



Question 89 of 125

Visceral afferent fibres from the ascending colon and proximal transverse colon travel to which of the following spinal cord segments:

a T6 – T8

b T8 – T10

c T10 – T11

d L1 – L2

e L3 – L4

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Anatomy: Abdomen

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Visceral afferent fibres from the ascending colon and proximal transverse colon travel to which of the following spinal cord segments:

a) T6 – T8 ✗
b) T8 – T10
c) T10 – T11 ✓
d) L1 – L2
e) L3 – L4

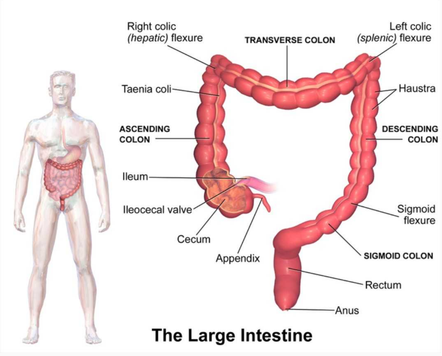
Answer

The visceral pain sensation from the ascending and transverse colon travels through the lesser splanchnic nerve to the T10 – T11 spinal cord segments hence pain is referred to the umbilical and hypogastric regions.

Pain from the descending and sigmoid colon is carried in the lumbar splanchnic nerves to the L1 and L2 spinal cord segments hence pain is referred to the inguinal region and thigh.

Notes

The large intestine extends from the distal end of the ileum to the anus, and comprises the caecum, appendix, colon, rectum and anal canal.



Blausen.com staff. "Blausen gallery 2014". Wikiversity Journal of Medicine. DOI:10.15347/wjm/2014.010. ISSN 20018762. (Own work) [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons

Colon

The colon continues from the caecum in the right groin as the ascending colon, which passes upwards through the right flank and into the right hypochondrium.

Just below the right lobe of the liver, it bends to the left forming the right colic flexure (hepatic flexure), and crosses the abdomen as the transverse colon to the left hypochondrium. The transverse colon is related superiorly to the liver, gallbladder, greater curvature of the stomach and the lateral end of the spleen.

At this point, just below the spleen, it bends downwards forming the left colic flexure (splenic flexure) and continues as the descending colon through the left flank and into the left groin. The splenic flexure is higher and more posterior than the hepatic flexure, and is attached to the diaphragm by the phrenicocolic ligament.

The colon enters the upper part of the pelvis as the sigmoid colon, which begins above the pelvic inlet and extends to the level of vertebra S3 where it is continuous with the rectum. This S-shaped structure is quite mobile except at its proximal and distal end which are attached to the descending colon and rectum respectively. Between these points, it is suspended by the sigmoid mesocolon.

The ascending and descending segments are retroperitoneal and the transverse and sigmoid segments are intraperitoneal.

Relations

Colon	Anterior relations	Posterior relations
Ascending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, right kidney
Transverse colon	Liver, gallbladder, stomach, greater omentum, anterior abdominal wall	Second part of duodenum, head of pancreas, upper end of mesentery, duodenojejunal flexure, coils of jejunum and ileum
Descending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, left kidney
Sigmoid colon	Bladder, uterus and upper vagina	Rectum, sacrum, ileum

Blood supply

The arterial supply to the colon is derived from the superior mesenteric artery (caecum, appendix, ascending colon, hepatic flexure, proximal two-thirds of transverse colon) and the inferior mesenteric artery (distal one-thirds of transverse colon, splenic flexure, descending colon, sigmoid colon).

As the terminal vessels of the superior mesenteric and inferior mesenteric artery approach the colon they split into many colic branches which anastomose with each other. These anastomoses from a continuous arterial channel which extends the length of the colon, the marginal artery.

At the junctional area of the supply of the superior and inferior mesenteric arteries, the anastomosis may not be sufficient, thus the splenic flexure is most susceptible to ischaemia.

Innervation

The visceral pain sensation from the ascending and transverse colon travels through the lesser splanchnic nerve to the T10 – T11 spinal cord segments hence pain is referred to the umbilical and hypogastric regions.

Pain from the descending and sigmoid colon is carried in the lumbar splanchnic nerves to the L1 and L2 spinal cord segments hence pain is referred to the inguinal region and thigh.

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Anatomy: Abdomen



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The retroduodenal region of the common bile duct:

a lies left of the gastroduodenal artery.

b lies posterior to the portal vein.

c lies posterior to the first part of the duodenum

d empties directly into the major duodenal papilla.

e lies posterior to the second part of the duodenum.

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Anatomy: Abdomen

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The retroduodenal region of the common bile duct:

a) **lies left of the gastroduodenal artery.** ✗
b) lies posterior to the portal vein.
c) lies posterior to the first part of the duodenum ✓
d) empties directly into the major duodenal papilla.
e) lies posterior to the second part of the duodenum.

Answer

The retroduodenal region is the middle one-third of the common bile duct which lies posterior to the first part of the duodenum. The gastroduodenal artery lies on its left aspect and the portal vein on its posterior aspect.

Notes

Biliary tree

The biliary tree begins in the liver parenchyma with the formation of the left and right hepatic duct which drain bile from the liver where it has been synthesised. These two ducts meet to form the common hepatic duct which runs near the liver, with the hepatic artery proper and portal vein in the free margin of the lesser omentum.

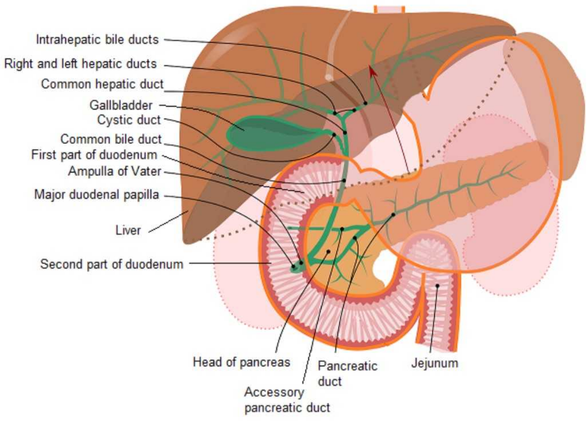
As the common hepatic duct descends, it is joined by the cystic duct, which is a continuation of the neck of the gallbladder. The common hepatic duct and the cystic duct combine to form the common bile duct. At this point the bile duct lies to the right of the hepatic artery proper and usually to the right of, and anterior to, the portal vein in the free margin of the lesser omentum.

As the common bile duct descends, it passes posterior to the first part of the duodenum before joining with the pancreatic duct from the pancreas, forming the hepatopancreatic ampulla (ampulla of Vater) at the major duodenal papilla, located in the second part of the duodenum. Surrounding the ampulla is the sphincter of Oddi, a collection of smooth muscle which can open to allow bile and pancreatic fluid to empty into the duodenum.

Common bile duct relations

The common bile duct can be divided into three main regions, based on its relation to the duodenum:

- The supraduodenal region is the upper one-third which lies in the free margin of the lesser omentum with the hepatic artery and portal vein. The common bile duct lies anterior to the portal vein and to the right of the hepatic artery proper.
- The retroduodenal region is the middle one-third which lies posterior to the first part of the duodenum. The gastroduodenal artery lies on its left aspect and the portal vein on its posterior aspect.
- The infraduodenal region is the lower one-third which lies in a groove on the posterior surface of the head of the pancreas, to the left of the second part of the duodenum and anterior to the right renal vein and inferior vena cava.



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Anatomy: Abdomen



Question 91 of 125

A 35 year old female is brought into hospital following a road traffic accident. Imaging shows retroperitoneal trauma. Which of the following structures is most likely affected:

a Stomach

b Abdominal aorta

c Caecum

d Tail of the pancreas

e Gallbladder

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Anatomy: Abdomen

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A 35 year old female is brought into hospital following a road traffic accident. Imaging shows retroperitoneal trauma. Which of the following structures is most likely affected:

a) Stomach ✖
b) Abdominal aorta ✔
c) Caecum
d) Tail of the pancreas
e) Gallbladder

Answer

The abdominal aorta is the only retroperitoneal structure listed.

Notes

The peritoneum is a continuous double-layered serous membrane.

The parietal peritoneum lines the walls of the abdominal cavity and the visceral peritoneum lines the viscera.

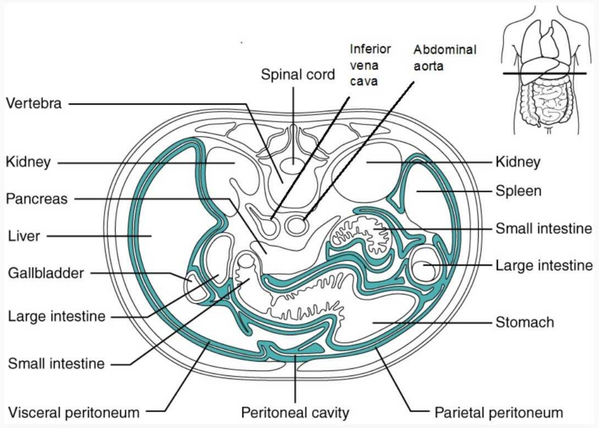
Between the parietal and visceral layers of peritoneum is a potential space, the peritoneal cavity.

Abdominal viscera are either suspended in the peritoneal cavity by folds of peritoneum called mesenteries (intraperitoneal viscera) or are outside the peritoneal cavity bound to the posterior abdominal wall (retroperitoneal viscera). Retroperitoneal organs are only covered in peritoneum on their anterior surface.

Innervation

The parietal peritoneum associated with the abdominal wall is innervated by somatic afferents carried in branches of the associated spinal nerves and is therefore sensitive to pressure, pain and temperature, and gives rise to well-localised pain. The diaphragmatic peritoneum is supplied by the phrenic nerve (C3 – C5) and the remainder of the parietal peritoneum is supplied segmentally by intercostal and lumbar nerves.

The visceral peritoneum is innervated by visceral afferents that accompany autonomic nerves back to the CNS and therefore activation gives rise to referred and poorly localised sensations of discomfort and to visceral motor activity.



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Retroperitoneal viscera

A useful mnemonic to help remember which abdominal organs are retroperitoneal is SAD PUCKER:

- Suprarenal glands
- Aorta and Inferior vena cava
- Duodenum (2nd and 3rd parts)
- Pancreas (except for the tail)
- Ureters (proximal) and Bladder
- Colon (ascending and descending)
- Kidneys
- (O)esophagus
- Rectum (lower two-thirds)

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Anatomy: Abdomen



Question 92 of 125

The quadrate and caudate lobes of the liver are separated by which of the following structures:

a Ligamentum venosum

b Ligamentum teres

c Gallbladder

d Inferior vena cava

e Porta hepatis

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The quadrate and caudate lobes of the liver are separated by which of the following structures:

a) **Ligamentum venosum** ✗
b) Ligamentum teres
c) Gallbladder
d) Inferior vena cava
e) Porta hepatis ✓

Answer

The porta hepatis is the central intraperitoneal fissure of the liver that separates the caudate and the quadrate lobes. The porta hepatis serves as the point of entry into the liver for the hepatic arteries and portal vein, and the exit point for the hepatic ducts.

Notes

The liver is the largest visceral organ in the body and is primarily located in the right hypochondrium and epigastric region, extending into the left hypochondrium.

Surface marking

Most of the liver is under the right dome of the diaphragm and deep to the lower thoracic wall. The inferior margin of the liver can be palpated descending below the right costal margin on deep inspiration.

The inferior margin is indicated by a line that joins points at the right tenth costal cartilage in the midaxillary line, the tip of the right ninth costal cartilage, the transpyloric plane in the midline, the tip of the left eighth costal cartilage and the left fifth rib in the midclavicular line.

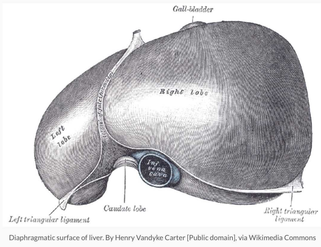
The superior margin is indicated by a line that joints a point on the left fifth rib at the midclavicular line to a corresponding point on the right side. The superior margin is concave in its central part and crosses behind the xiphisternal joint.

Anatomical surfaces

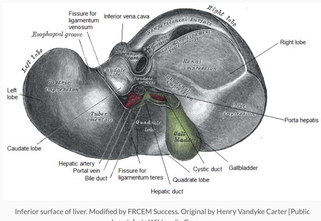
The liver has a diaphragmatic surface in the anterior, superior, and posterior directions and a visceral surface in the inferior direction.

The diaphragmatic surface of the liver is related anteriorly to the anterior abdominal wall and rib cage and superiorly to the diaphragm.

The visceral surface of the liver is related to the oesophagus, right anterior part of the stomach, superior part of the duodenum, lesser omentum, gallbladder, right colic flexure, right transverse colon, right kidney and right adrenal gland.



Diaphragmatic surface of liver. By Henry Vandyke Carter [Public domain], via Wikimedia Commons



Inferior surface of liver. Modified by FRCEM Success. Original by Henry Vandyke Carter [Public domain], via Wikimedia Commons

Lobes

There are four anatomical lobes to the liver.

- The liver is divided into the left and right lobe by the fossae for the gallbladder and the inferior vena cava.
- The caudate lobe sits between the fissure for the ligamentum venosum and the inferior vena cava.
- The quadrate lobe is located between the gallbladder and the fissure for the ligamentum teres.

The porta hepatis is the central intraperitoneal fissure of the liver that separates the caudate and the quadrate lobes. The porta hepatis serves as the point of entry into the liver for the hepatic arteries and portal vein, and the exit point for the hepatic ducts.

Liver lobules

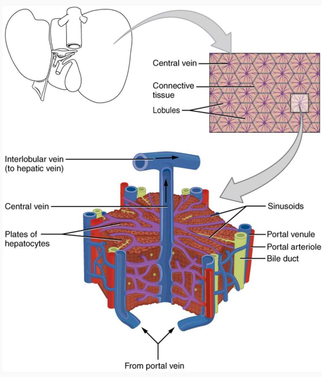
Microscopically, hepatocytes are arranged into lobules which are the functional units of the liver. Each lobule is hexagonal-shaped, and is drained by a venule in its centre, called a central vein (which drains to the hepatic vein).

At the periphery of the hexagon are three structures collectively known as the portal triad, comprising:

- a portal arteriole (a branch of the hepatic artery),
- a portal venule (a branch of the hepatic portal vein),
- a bile duct.

The portal triad also contains lymphatic vessels and vagal parasympathetic nerve fibres.

The liver sinusoids serve as a location for mixing of the oxygen-rich blood from the hepatic artery and the nutrient-rich blood from the portal vein.



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Blood supply

The liver has a unique dual blood supply. The arterial supply to the liver is from the left and right hepatic arteries derived from the hepatic artery proper, a branch of the common hepatic artery from the coeliac trunk.

The hepatic portal vein (formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2) supplies the liver with deoxygenated blood carrying nutrients absorbed from the small intestine.

Venous drainage of the liver is achieved through three hepatic veins, which return the venous blood to the inferior vena cava just inferior to the diaphragm.

Lymphatic drainage

The lymphatic vessels of the liver drain into hepatic lymph nodes which empty in the coeliac lymph nodes.

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Anatomy: Abdomen



Question 93 of 125

A 19 year old male is brought to ED having sustained a handlebar injury with blunt trauma to his upper abdomen whilst riding his scooter. Which of the following is the most commonly injured organ:

a Pancreas

b Transverse colon

c Spleen

d Duodenum

e Kidney

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Anatomy: Abdomen

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a) Pancreas ✗
b) Transverse colon
c) Spleen ✓
d) Duodenum
e) Kidney

Answer

The liver and spleen are the most commonly injured organs with this clinical picture.

Notes

The intraperitoneal spleen lies against the diaphragm, in the area of rib 9 – 11. It lies in the left hypochondrium of the abdomen. The spleen cannot normally be palpated on clinical examination.

The spleen is an organ of the reticuloendothelial system and acts:

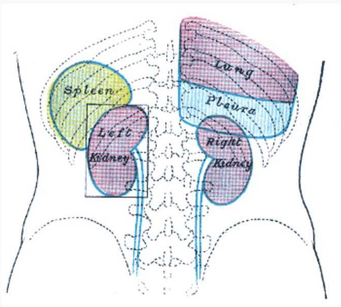
- to filter blood to remove old and defective blood cells
- as a blood reservoir
- to produce white blood cells
- to produce an immune response

Relations

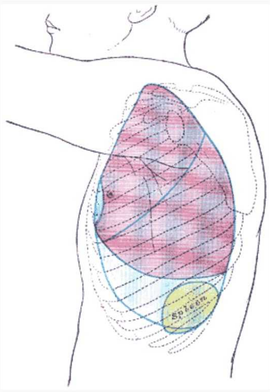
The spleen lies posterior to the stomach, superior to the left colic flexure and laterally to the left kidney and tail of the pancreas.

Surface markings

The spleen projects onto the left side and back in the area of ribs 9 – 11. The spleen follows the contour of rib 10 and extends from the superior pole of the left kidney to just posterior to the midaxillary line.



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By Henry Vandyke Carter [Public domain], via Wikimedia Commons

Splenic rupture

This most commonly occurs due to localised trauma to the left upper quadrant. It may be associated with left lower rib fractures. Because the spleen has an extremely thin capsule it is susceptible to injury even when there is no damage to surrounding structures and because the spleen is highly vascular, when ruptured, it bleeds profusely into the peritoneal cavity.

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Anatomy: Abdomen



Question 94 of 125

The hepatic portal vein is formed from the union of which of the following veins:

a Superior mesenteric and inferior mesenteric veins

b Superior mesenteric and hepatic veins

c Right and left hepatic veins

d Superior mesenteric and splenic veins

e Superior mesenteric and gastric veins

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Anatomy: Abdomen

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The hepatic portal vein is formed from the union of which of the following veins:

a) **Superior mesenteric and inferior mesenteric veins** ✖
b) Superior mesenteric and hepatic veins
c) Right and left hepatic veins
d) Superior mesenteric and splenic veins ✔
e) Superior mesenteric and gastric veins

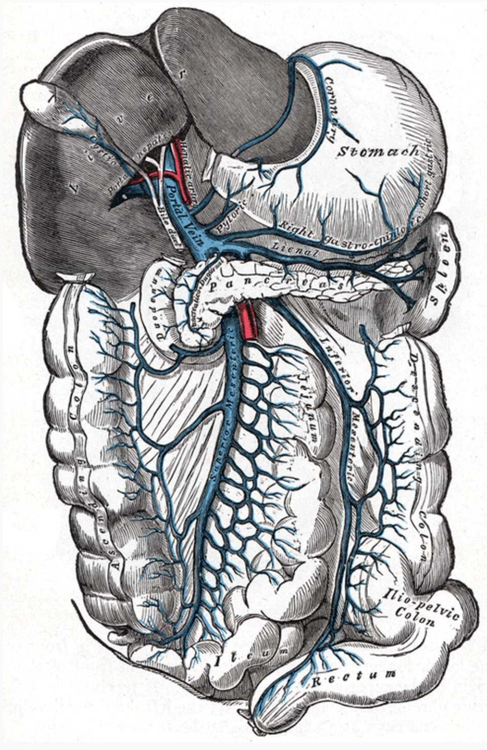
Answer

The portal vein is formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2.

Notes

The portal vein is the final common pathway for the transport of venous blood from the spleen, pancreas, gallbladder and abdominal part of the gastrointestinal tract.

It is formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2.



By Henry Vandyke Carter [Public domain], via Wikimedia Commons

Portosystemic anastomoses

The hepatic portal system drains deoxygenated nutrient-rich blood from the visceral organs of the abdomen to the liver. Normally 100% of portal venous blood flow is recovered from the hepatic veins. In patients with elevated portal vein pressure e.g. from cirrhosis, there is significantly less blood flow to the liver and the rest of the blood enters collateral channels which drain into the systemic circulation at specific points.

Portosystemic anastomoses occur at certain specific points, the largest of these being:

- The gastroesophageal junction around the cardia of the stomach where the left gastric vein and its tributaries from a portosystemic anastomosis with tributaries to the azygos system of veins of the caval system
- The anus where the superior rectal vein of the portal system anastomoses with the middle and inferior rectal veins of the systemic venous system
- The anterior abdominal wall around the umbilicus where the portal paraumbilical veins anastomose with systemic veins on the anterior abdominal wall

When pressure in the portal vein is elevated, venous enlargement (varices) tends to occur at and around these sites producing:

- oesophageal varices at the gastroesophageal junction
- varices at the anorectal junction
- caput medusae at the umbilicus

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Anatomy: Abdomen



Question 95 of 125

Regarding the appendix, which of the following statements is CORRECT:

a The psoas sign may be positive in retrocaecal appendicitis.

b The appendix has a highly variable attachment site to the caecum.

c The appendix is a retroperitoneal structure.

d The surface projection of the base of the appendix is called Murphy's point.

e The subcaecal position is the most common position of the appendix.

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Regarding the appendix, which of the following statements is CORRECT:

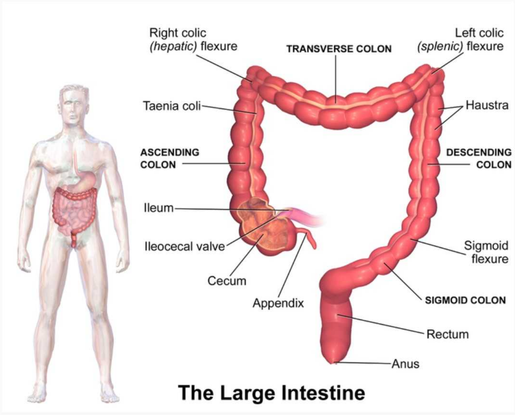
a) **The psoas sign may be positive in retrocaecal appendicitis.** ✔
b) The appendix has a highly variable attachment site to the caecum.
c) The appendix is a retroperitoneal structure.
d) The surface projection of the base of the appendix is called Murphy's point.
e) The subcaecal position is the most common position of the appendix.

Answer

The most common position is retrocaecal, followed by pelvic. The retrocaecal appendix is related anteriorly to the caecum and posteriorly to the psoas major and iliacus muscle. The psoas sign may be positive in retrocaecal appendicitis. Irritation of the psoas muscle (hip flexor) gives rise to pain when the patient's right thigh is extended from a flexed position as the muscle is stretched.

Notes

The large intestine extends from the distal end of the ileum to the anus, and comprises the caecum, appendix, colon, rectum and anal canal.



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Caecum

The intraperitoneal caecum is the first part of the large intestine. It is inferior to the ileocaecal opening and lies in the right iliac fossa. The caecum is continuous with the ascending colon at the entrance of the ileum and is usually in contact with the anterior abdominal wall. It may cross the pelvic brim to lie in the true pelvis.

Appendix

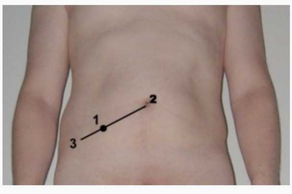
The appendix is attached to the posteromedial wall of the caecum, just inferior to the end of the ileum. The appendix is a narrow, hollow, blind-ended tube. It has large aggregations of lymphoid tissue in its walls and is suspended from the terminal ileum by the mesoappendix.

Its point of attachment to the caecum is consistent with the highly visible free taeniae leading directly to the base of the appendix but the rest of its location is highly variable. It may be:

- 1) posterior to the caecum or the lower ascending colon, or both, in a retrocaecal or retrocolic position
- 2) suspended over the pelvic brim in a pelvic or descending position
- 3) below the caecum in a subcaecal position
- 4) anterior to the terminal ileum, possibly contacting with the body wall in a pre-ileal position or posterior to the terminal ileum in a post-ileal position.

The most common position is retrocaecal, followed by pelvic. The retrocaecal appendix is related anteriorly to the caecum and posteriorly to the psoas major and iliacus muscle. The psoas sign may be positive in retrocaecal appendicitis. Irritation of the psoas muscle (hip flexor) gives rise to pain when the patient's right thigh is extended from a flexed position as the muscle is stretched.

The surface projection of the base of the appendix is at the junction of the lateral and middle one-third of a line from the anterior superior iliac spine to the umbilicus (McBurney's point). People with appendicitis may describe pain at this location.



(1 = McBurney's point, 2 = Umbilicus, 3 = ASIS) By Steven Fruitsmaak [GFDL (http://www.gnu.org/copyleft/fdl.html) or CC-BY-SA-3.0 (http://creativecommons.org/licenses/by-sa/3.0/)], via Wikimedia Commons

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Anatomy: Abdomen



Question 96 of 125

The oesophagus passes through the diaphragm at which vertebral level:

a T8

b T9

c T10

d T11

e T12

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Anatomy: Abdomen

Question 96 of 125

The oesophagus passes through the diaphragm at which vertebral level:

a) T8 ✗
b) T9
c) T10 ✓
d) T11
e) T12

Answer

The abdominal oesophagus emerges through the oesophageal hiatus in the diaphragm at vertebral level T10.

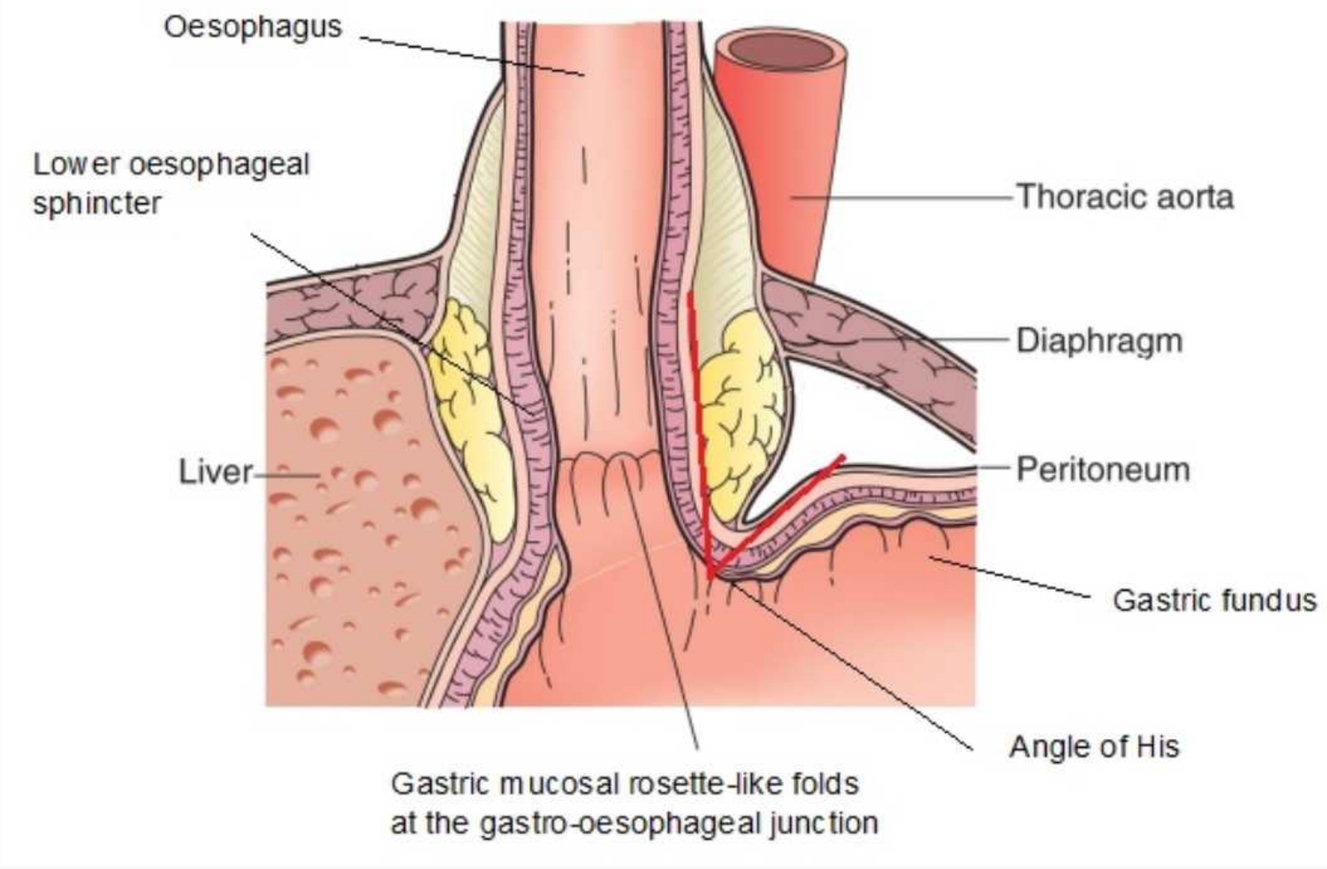
Notes

The abdominal oesophagus represents the short distal part (about 2 cm) of the oesophagus located in the abdominal cavity. Emerging through the right crus of the diaphragm at the level of vertebra T10, it passes from the oesophageal hiatus to the cardiac orifice of the stomach just left of the midline at the level of vertebra T11.

The lower oesophageal sphincter is a physiological sphincter located at the gastro-oesophageal junction.

Anatomical factors that help guard against gastric reflux include:

- The diaphragmatic pinchcock effect where at the oesophageal hiatus, right crural fibres exert pressure on the oesophageal wall and serve as an extrinsic sphincter
- The lower oesophageal sphincter which is a high-pressure zone of smooth muscle in the oesophageal wall maintained in a state of tonic contraction (except during swallowing, belching or vomiting)
- Intra-abdominal pressure which maintains the oesophagus in a state of collapse when empty
- The angle of His formed at the junction of the oesophagus and the gastric fundus, which together with the posterolateral position of the gastric fundus, minimises contact of gastric content with the gastro-oesophageal junction
- The gastric mucosal rosette-like folds formed at the gastro-oesophageal junction which compress against each other with increased intraabdominal pressure to prevent reflux



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Anatomy: Abdomen



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The portal triad comprises all of the following structures EXCEPT for:

a Branches of the hepatic vein

b Branches of the portal vein

c Branches of the hepatic artery

d Bile ducts

e Vagal parasympathetic nerve fibres

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a) Branches of the hepatic vein ✔
b) Branches of the portal vein
c) Branches of the hepatic artery
d) Bile ducts
e) Vagal parasympathetic nerve fibres

Answer

Microscopically, hepatocytes are arranged into lobules which are the functional units of the liver. Each lobule is hexagonal-shaped, and is drained by a venule in its centre called a central vein (which drains to the hepatic vein). At the periphery of the hexagonal liver lobules are three structures collectively known as the portal triad, comprising a portal arteriole (a branch of the hepatic artery), a portal venule (a branch of the hepatic portal vein) and a bile duct. The portal triad also contains lymphatic vessels and vagal parasympathetic nerve fibres.

Notes

The liver is the largest visceral organ in the body and is primarily located in the right hypochondrium and epigastric region, extending into the left hypochondrium.

Surface marking

Most of the liver is under the right dome of the diaphragm and deep to the lower thoracic wall. The inferior margin of the liver can be palpated descending below the right costal margin on deep inspiration.

The inferior margin is indicated by a line that joins points at the right tenth costal cartilage in the midaxillary line, the tip of the right ninth costal cartilage, the transpyloric plane in the midline, the tip of the left eighth costal cartilage and the left fifth rib in the midclavicular line.

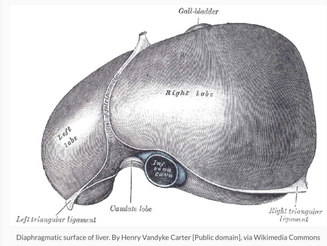
The superior margin is indicated by a line that joints a point on the left fifth rib at the midclavicular line to a corresponding point on the right side. The superior margin is concave in its central part and crosses behind the xiphisternal joint.

Anatomical surfaces

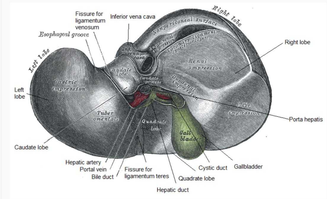
The liver has a diaphragmatic surface in the anterior, superior, and posterior directions and a visceral surface in the inferior direction.

The diaphragmatic surface of the liver is related anteriorly to the anterior abdominal wall and rib cage and superiorly to the diaphragm.

The visceral surface of the liver is related to the oesophagus, right anterior part of the stomach, superior part of the duodenum, lesser omentum, gallbladder, right colic flexure, right transverse colon, right kidney and right adrenal gland.



Diaphragmatic surface of liver. By Henry Vandyke Carter [Public domain], via Wikimedia Commons



Inferior surface of liver. Modified by FRCEM Success. Original by Henry Vandyke Carter [Public domain], via Wikimedia Commons

Lobes

There are four anatomical lobes to the liver.

- The liver is divided into the left and right lobe by the fossae for the gallbladder and the inferior vena cava.
- The caudate lobe sits between the fissure for the ligamentum venosum and the inferior vena cava.
- The quadrate lobe is located between the gallbladder and the fissure for the ligamentum teres.

The porta hepatis is the central intraperitoneal fissure of the liver that separates the caudate and the quadrate lobes. The porta hepatis serves as the point of entry into the liver for the hepatic arteries and portal vein, and the exit point for the hepatic ducts.

Liver lobules

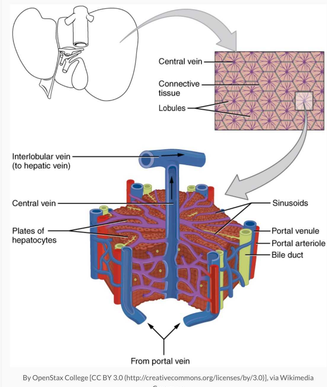
Microscopically, hepatocytes are arranged into lobules which are the functional units of the liver. Each lobule is hexagonal-shaped, and is drained by a venule in its centre, called a central vein (which drains to the hepatic vein).

At the periphery of the hexagon are three structures collectively known as the portal triad, comprising:

- a portal arteriole (a branch of the hepatic artery),
- a portal venule (a branch of the hepatic portal vein),
- a bile duct.

The portal triad also contains lymphatic vessels and vagal parasympathetic nerve fibres.

The liver sinusoids serve as a location for mixing of the oxygen-rich blood from the hepatic artery and the nutrient-rich blood from the portal vein.



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Blood supply

The liver has a unique dual blood supply. The arterial supply to the liver is from the left and right hepatic arteries derived from the hepatic artery proper, a branch of the common hepatic artery from the coeliac trunk.

The hepatic portal vein (formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2) supplies the liver with deoxygenated blood carrying nutrients absorbed from the small intestine.

Venous drainage of the liver is achieved through three hepatic veins, which return the venous blood to the inferior vena cava just inferior to the diaphragm.

Lymphatic drainage

The lymphatic vessels of the liver drain into hepatic lymph nodes which empty in the coeliac lymph nodes.

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Anatomy: Abdomen



Question 98 of 125

The superficial inguinal ring is located at which of the following sites:

a Just superior to the midpoint of the inguinal ligament

b Superior to a point midway between the anterior superior iliac spine and the pubic symphysis

c Superior to a point midway between the anterior superior iliac spine and the pubic tubercle

d Just superior to the pubic tubercle

e Immediately lateral to the inferior epigastric vessels

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Anatomy: Abdomen

Question 98 of 125

The superficial inguinal ring is located at which of the following sites:

a) **Just superior to the midpoint of the inguinal ligament** ✗
b) Superior to a point midway between the anterior superior iliac spine and the pubic symphysis
c) Superior to a point midway between the anterior superior iliac spine and the pubic tubercle
d) Just superior to the pubic tubercle ✓
e) Immediately lateral to the inferior epigastric vessels

Answer

The superficial inguinal ring is located just superior to the pubic tubercle.

Notes

Space	Inguinal canal
Position	Between deep and superficial inguinal rings, just above and parallel to lower half of inguinal ligament
Anterior wall	Formed by external oblique aponeurosis (reinforced by internal oblique muscle laterally)
Posterior wall	Formed by transversalis fascia (reinforced by conjoint tendon medially)
Roof	Formed by transversus abdominis and internal oblique muscles
Floor	Formed by medial one-half of inguinal ligament (reinforced by lacunar ligament medially)
Deep inguinal ring	Opening in transversalis fascia, located just superior to mid-inguinal point (midway between ASIS and pubic symphysis)
Superficial inguinal ring	Opening in external oblique aponeurosis, located just superior to pubic tubercle
Contents	Genital branch of genitofemoral nerve, spermatic cord, round ligament, ilioinguinal nerve

Position

The inguinal canal is a slit-like passage that extends in a downwards and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the deep inguinal ring and continues for approximately 4 cm, ending at the superficial inguinal ring.

Roof, walls and floor

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle, and reinforced by the internal oblique muscle laterally.

The posterior wall of the inguinal canal is formed along its entire length by the transversalis fascia and reinforced by the conjoint tendon medially.

The roof of the inguinal canal is formed by arching fibres of the transversus abdominis and internal oblique muscles.

The floor of the inguinal canal is formed by the medial one-half of the inguinal ligament, reinforced medially by the lacunar ligament.

Deep inguinal ring

The deep inguinal ring, the opening in the transversalis fascia, is the beginning of the inguinal canal.

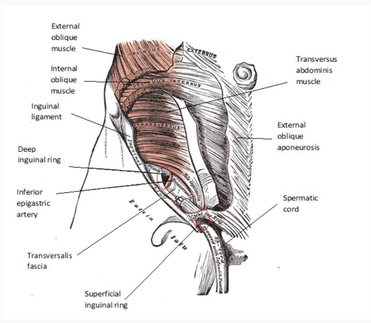
The deep inguinal ring is located just superior to a point midway between the anterior superior iliac spine and the pubic symphysis (the mid-inguinal point). N.B. Some sources state it is located at a slightly different site, just superior to a point midway between the anterior superior iliac spine and the pubic tubercle (the midpoint of the inguinal ligament).

It lies just above the inguinal ligament and immediately lateral to the inferior epigastric vessels; the femoral artery can be palpated in the same position but below the inguinal ligament.

Superficial inguinal ring

The superficial inguinal ring is the end of the inguinal canal.

The superficial inguinal ring is located just superior to the pubic tubercle. It is a triangular opening in the aponeurosis of the external oblique, with its apex pointing superolaterally and its base formed by the pubic crest.



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Contents

The inguinal canal contains:

- the genital branch of the genitofemoral nerve (within the spermatic cord in men)
- the spermatic cord in men
- the round ligament in women
- the ilioinguinal nerve (passes through part of the canal, exiting the superficial inguinal ring with the other contents)

Inguinal hernia

An inguinal hernia is the protrusion of a peritoneal sac through a weakened part of the abdominal wall in the groin.

Hernia	Indirect inguinal hernia	Direct inguinal hernia
Aetiology	Congenital – patent processus vaginalis	Acquired – weakened abdominal musculature
Mechanism	Peritoneal sac herniates through deep inguinal ring	Peritoneal sac herniates directly through posterior wall of inguinal canal
Relation to inferior epigastric vessels	Lateral to inferior epigastric vessels	Medial to inferior epigastric vessels

In indirect inguinal hernias, the most common type, the peritoneal sac enters the inguinal canal by passing through the deep inguinal ring, due to a patent embryonic processus vaginalis. If the entire processus vaginalis remains patent, the peritoneal sac may traverse the length of the canal, exit the superficial inguinal ring and continue into the scrotum or labia majora.

In direct inguinal hernias, the peritoneal sac passes directly through the posterior wall of the inguinal canal. It usually occurs when abdominal musculature has been weakened, in older men, following surgery or due to persistent raised intra-abdominal pressure. This type of hernia does not traverse the inguinal canal, but may still exit the superficial inguinal ring to enter the scrotum.

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Anatomy: Abdomen



Question 99 of 125

The abdominal aorta lies posterior to which of the following parts of the duodenum:

a First part

b Second part

c First and second parts

d Second and third parts

e Third and fourth parts

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Anatomy: Abdomen

Question 99 of 125

The abdominal aorta lies posterior to which of the following parts of the duodenum:

a) First part ✗
b) Second part
c) First and second parts
d) Second and third parts
e) Third and fourth parts ✓

Answer

The inferior (third) part is the longest section, crossing the inferior vena cava, the aorta and the vertebral column at the level of vertebra L3 and lying inferior to the pancreas. The ascending (fourth) part passes upwards on, or to the left of the aorta to approximately the upper border of vertebra L2 and terminates at the duodenojejunal flexure.

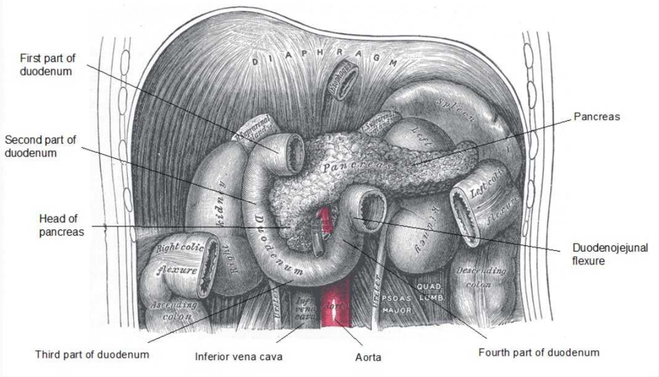
Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum. The first part of the small intestine is the duodenum.

The duodenum is a C-shaped structure, adjacent to the head of the pancreas, and above the level of the umbilicus. It is retroperitoneal except for its proximal part which is connected to the liver by the hepatoduodenal ligament of the lesser omentum.

Parts of the duodenum

- The superior (first) part extends from the pyloric orifice of the stomach to the neck of the gallbladder, lies just to the right of the body of vertebra L1, and passes anterior to the inferior vena cava and superior to the head of the pancreas.
- The descending (second) part is just to the right of the midline, extending from the neck of the gallbladder to the lower border of vertebra L3 and lying lateral to the head of the pancreas. This part contains the major duodenal papilla which is the common entrance for the bile and pancreatic ducts.
- The inferior (third) part is the longest section, crossing the inferior vena cava, the aorta and the vertebral column at the level of vertebra L3 and lying inferior to the pancreas.
- The ascending (fourth) part passes upwards on, or to the left of the aorta to approximately the upper border of vertebra L2 and terminates at the duodenojejunal flexure.



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Blood supply

The arterial supply of the duodenum is primarily from the pancreaticoduodenal arteries, branches of the superior mesenteric artery and the gastroduodenal artery (branch of the common hepatic artery from the coeliac trunk).

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Anatomy: Abdomen



Question 100 of 125

Regarding the external oblique muscle, which of the following statements is INCORRECT:

a It is the largest and most superficial of the anterior abdominal muscles.

b Its aponeurosis forms the linea alba at the midline.

c It originates from the xiphoid process.

d It inserts into the lateral lip of the iliac crest.

e The lower free border of the external oblique aponeurosis forms the inguinal ligament.

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Anatomy: Abdomen

Question 100 of 125

Regarding the external oblique muscle, which of the following statements is INCORRECT:

a) **It is the largest and most superficial of the anterior abdominal muscles.** ✖
b) Its aponeurosis forms the linea alba at the midline.
c) It originates from the xiphoid process. ✔
d) It inserts into the lateral lip of the iliac crest.
e) The lower free border of the external oblique aponeurosis forms the inguinal ligament.

Answer

The external oblique is the largest and most superficial of the anterior abdominal muscles, lying just deep to the superficial fascia. The external oblique originates from the outer surfaces of the lower eight ribs, its fibres running in an inferomedial direction before inserting onto the lateral lip of the iliac crest.

Notes

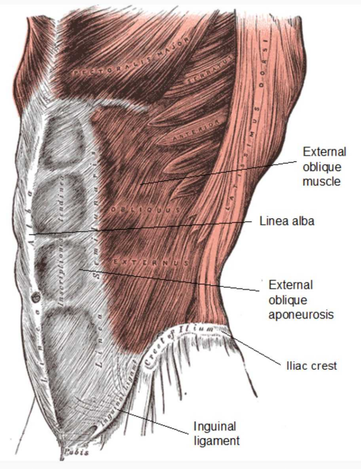
There are five muscles in the anterolateral group of abdominal wall muscles; three flat muscles whose fibres begin posterolaterally and pass anteriorly before being replaced by an aponeurosis as the muscle continues towards the midline (external oblique, internal oblique, transversus abdominis) and two vertical muscles enclosed by the tendinous sheath formed by the aponeuroses of the flat muscles (rectus abdominis, pyramidalis).

External oblique

The external oblique is the largest and most superficial of the anterior abdominal muscles, lying just deep to the superficial fascia. The external oblique originates from the outer surfaces of the lower eight ribs, its fibres running in an inferomedial direction before inserting onto the lateral lip of the iliac crest.

The external oblique has a large aponeurotic component that covers the anterior part of the abdominal wall and forms the linea alba at the midline, together with the aponeuroses from the internal oblique and the transversus abdominis. The linea alba extends from the xiphoid process to the pubic symphysis.

The lower free border of the external oblique aponeurosis forms the inguinal ligament on each side (which runs between the anterior superior iliac spine laterally and the pubic tubercle medially).



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Internal oblique

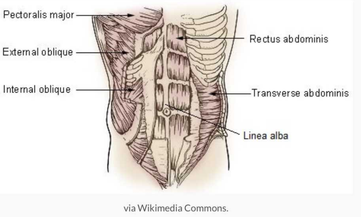
The internal oblique muscle lies deep to the external oblique. Its fibres run in a superomedial direction, originating from the thoracolumbar fascia, the iliac crest and the lateral two-thirds of the inguinal ligament and inserting onto the inferior border of the lower 3 – 4 ribs, the linea alba, the pubic crest and pectineal line.

Transversus abdominis

The transversus abdominis is the innermost of the flat anterior abdominal muscles, lying deep to the internal oblique. It originates from the thoracolumbar fascia, the iliac crest, the lateral one-third of the inguinal ligament and the 7th – 12th costal cartilages and inserts onto the linea alba, the pubic crest and the pectineal line.

Rectus abdominis

The rectus abdominis is a long muscle that extends the length of the anterior abdominal wall. It originates from the pubic crest, pubic tubercle and pubic symphysis and inserts onto the costal cartilages of ribs 5 – 7 and to the xiphoid process. It is a paired muscle, separated in the midline by the linea alba.



via Wikimedia Commons.

Function

The abdominal wall muscles form a firm, but flexible wall that keeps the abdominal viscera within the abdominal cavity, protects the viscera from injury and helps maintain the position of the viscera in the erect posture against the action of gravity.

The muscles act together to flex and rotate the vertebral column.

In addition, contraction of these muscles assists in forced expiration, and in coughing and vomiting, by pushing the viscera upwards. All of these muscles are involved in any action that increases intra-abdominal pressure, including childbirth, micturition and defaecation.

Innervation

The anterior abdominal wall muscles are innervated by the anterior rami of T7 – T12 and L1.

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Anatomy: Abdomen



Question 101 of 125

Which of the following abdominal regions does the caecum occupy:

a Right iliac fossa

b Left iliac fossa

c Suprapubic region

d Right flank

e Umbilicus

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Anatomy: Abdomen

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Which of the following abdominal regions does the caecum occupy:

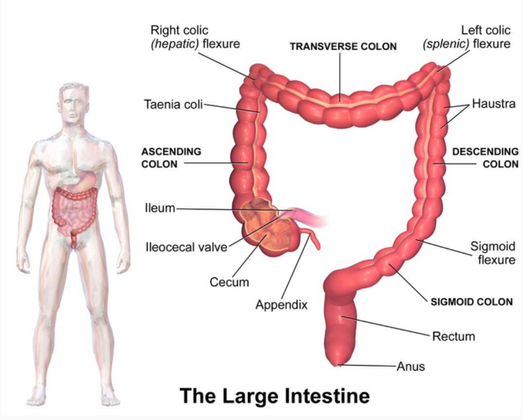
a) **Right iliac fossa** ✔
b) Left iliac fossa
c) Suprapubic region
d) Right flank
e) Umbilicus

Answer

The intraperitoneal caecum is the first part of the large intestine. It is inferior to the ileocaecal opening and lies in the right iliac fossa.

Notes

The large intestine extends from the distal end of the ileum to the anus, and comprises the caecum, appendix, colon, rectum and anal canal.



Blausen.com staff. "Blausen gallery 2014". Wikiversity Journal of Medicine. DOI:10.15347/wjm/2014.010. ISSN 20018762. (Own work) [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons

Caecum

The intraperitoneal caecum is the first part of the large intestine. It is inferior to the ileocaecal opening and lies in the right iliac fossa. The caecum is continuous with the ascending colon at the entrance of the ileum and is usually in contact with the anterior abdominal wall. It may cross the pelvic brim to lie in the true pelvis.

Appendix

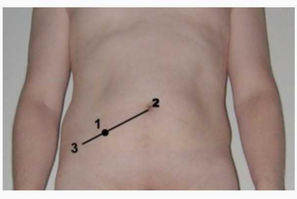
The appendix is attached to the posteromedial wall of the caecum, just inferior to the end of the ileum. The appendix is a narrow, hollow, blind-ended tube. It has large aggregations of lymphoid tissue in its walls and is suspended from the terminal ileum by the mesoappendix.

Its point of attachment to the caecum is consistent with the highly visible free taeniae leading directly to the base of the appendix but the rest of its location is highly variable. It may be:

- 1) posterior to the caecum or the lower ascending colon, or both, in a retrocaecal or retrocolic position
- 2) suspended over the pelvic brim in a pelvic or descending position
- 3) below the caecum in a subcaecal position
- 4) anterior to the terminal ileum, possibly contacting with the body wall in a pre-ileal position or posterior to the terminal ileum in a post-ileal position.

The most common position is retrocaecal, followed by pelvic. The retrocaecal appendix is related anteriorly to the caecum and posteriorly to the psoas major and iliacus muscle. The psoas sign may be positive in retrocaecal appendicitis. Irritation of the psoas muscle (hip flexor) gives rise to pain when the patient's right thigh is extended from a flexed position as the muscle is stretched.

The surface projection of the base of the appendix is at the junction of the lateral and middle one-third of a line from the anterior superior iliac spine to the umbilicus (McBurney's point). People with appendicitis may describe pain at this location.



(1 = McBurney's point, 2 = Umbilicus, 3 = ASIS) By Steven Fruitsmaak [GFDL (http://www.gnu.org/copyleft/fdl.html) or CC-BY-SA-3.0 (http://creativecommons.org/licenses/by-sa/3.0/)], via Wikimedia Commons

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Anatomy: Abdomen



Question 102 of 125

The abdominal wall is divided into a simple four quadrant pattern by the vertical median plane intersecting with which of the following transverse planes:

a Transumbilical plane passing through the umbilicus

b Intertubercular plane connecting the tubercles of the iliac crests

c Transpyloric plane lying halfway between the jugular notch and the pubic symphysis

d Subcostal plane lying immediately inferior to the costal margins

e Interspinous plane connecting the anterior superior iliac spines

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Anatomy: Abdomen



Question 102 of 125

The abdominal wall is divided into a simple four quadrant pattern by the vertical median plane intersecting with which of the following transverse planes:

a) Transumbilical plane passing through the umbilicus ✔
b) Intertubercular plane connecting the tubercles of the iliac crests
c) Transpyloric plane lying halfway between the jugular notch and the pubic symphysis
d) Subcostal plane lying immediately inferior to the costal margins
e) Interspinous plane connecting the anterior superior iliac spines

Answer

The abdominal wall may be divided into a simple four-quadrant topographical pattern by a horizontal line passing through the umbilicus and the intervertebral disc between vertebrae L3 and L4 (transumbilical plane) intersecting with the vertical median plane.

Notes

Four-quadrant pattern

The abdominal wall may be divided into a simple four-quadrant topographical pattern by a horizontal line passing through the umbilicus and the intervertebral disc between vertebrae L3 and L4 (transumbilical plane) intersecting with the vertical median plane; this forms the right upper, the left upper, the right lower and the left lower quadrants.

Nine-region pattern

The nine-region topographical description is based on two horizontal and two vertical planes.

The two vertical planes pass on each side from the midpoint of the clavicle to the midpoint of the inguinal ligament.

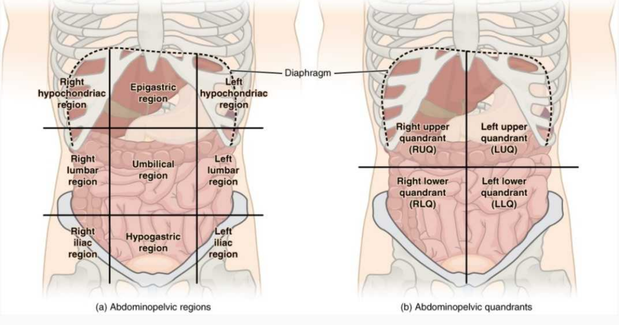
The inferior horizontal plane (the intertubercular plane) connects the tubercles of the iliac crests and passes posteriorly through the body of vertebra L5.

The superior horizontal plane may be taken as the subcostal or the transpyloric plane:

- The subcostal plane lies immediately inferior to the costal margins at the lower border of the tenth costal cartilage and passes posteriorly through the body of vertebra L3.
- The transpyloric plane lies halfway between the jugular notch and the pubic symphysis, intersecting with the costal margin at the ends of the ninth costal cartilage and passing posteriorly through the body of vertebra L1.

The nine regions are designated (read as if reading a book):

- the right hypochondriac region
- the epigastric region
- the left hypochondriac region
- the right lumbar region (or flank)
- the umbilical region
- the left lumbar region (or flank)
- the right iliac region
- the pubic (or hypogastric) region
- the left iliac region



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Anatomy: Abdomen

Question 103 of 125



The mesentery connects which of the following structures to the posterior abdominal wall:

a Transverse colon

b Stomach

c Jejunum and ileum

d Duodenum

e Liver

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Anatomy: Abdomen

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The mesentery connects which of the following structures to the posterior abdominal wall:

a) **Transverse colon** ✗
b) Stomach
c) Jejunum and ileum ✓
d) Duodenum
e) Liver

Answer

The mesentery is a large, fan-shaped, double-layered fold of peritoneum that connects the jejunum and ileum to the posterior abdominal wall. Its superior attachment is at the duodenojejunal junction, just to the left of the upper lumbar part of the vertebral column. It passes obliquely downwards and to the right, ending at the ileocaecal junction near the upper border of the right sacroiliac joint.

Notes

Structure	Key anatomy
Peritoneal cavity	Divided into greater and lesser sacs
Greater sac	Divided into supracolic and infracolic compartments by transverse mesocolon, compartments connected by paracolic gutters
Supracolic compartment	Contains stomach, liver and spleen, lies under cover of costal limits of thoracic cage
Infracolic compartment	Divided into left and right parts by oblique attachment of mesentery, contains small intestine and ascending/descending colon, continuous with pelvic cavity
Lesser sac (omental bursa	Lies posterior to stomach and liver and anterior to pancreas, continuous with greater sac through epiploic foramen
Greater omentum	Descends from greater curvature of stomach and first part of duodenum, drapes inferiorly over transverse colon, jejunum and ileum, folds back up and ascends to adhere to transverse colon/mesocolon before arriving at posterior abdominal wall
Lesser omentum	Extends from lesser curvature of stomach and first part of duodenum to inferior surface of liver
Mesentery	Connects jejunum and ileus to posterior abdominal wall, attaches superiorly to duodenojejunal junction and passes oblique downwards and to the right to end at ileocecal junction
Transverse mesocolon	Connects transverse colon to posterior abdominal wall, leaves posterior abdominal wall across anterior surface of head and body of pancreas and passes outwards to surround transverse colon
Sigmoid mesocolon	Connects sigmoid colon to abdominal wall, V-shaped fold with apex near division of left common iliac artery, left limb descending along medial border of left psoas major muscle and right limb descending into pelvis to end at vertebral level S3

Compartments of the peritoneal cavity

The peritoneal cavity is divided into the greater sac and the omental bursa (lesser sac).

The greater sac accounts for most of the space in the peritoneal cavity, beginning superiorly at the diaphragm and continuing inferiorly in the pelvic cavity. It is further divided into two compartments by the transverse mesocolon:

- The supracolic compartment lies above the transverse mesocolon and contains the stomach, liver and spleen. It lies largely under cover of the costal limits of the thoracic cage.
- The infracolic compartment lies below the transverse mesocolon, is divided into left and right parts by the oblique attachment of the mesentery and contains the small intestine and the ascending and descending colon. The left infracolic compartment is continuous with the pelvic cavity.

The supracolic and infracolic compartments are connected by the paracolic gutters which lie between the posterolateral abdominal wall and the lateral aspect of the ascending or descending colon.

The omental bursa (lesser sac) is a smaller subdivision of the peritoneal cavity posterior to the stomach and liver and anterior to the pancreas, and is continuous with the greater sac through the epiploic foramen.

Omenta

The omenta are double layers of peritoneum that extends from the stomach and proximal part of the duodenum to other organs.

The greater omentum descends from the greater curvature of the stomach and first part of the duodenum, drapes inferiorly over the transverse colon and the coils of the jejunum and ileum, then folds back up posteriorly and ascends to become adherent to the peritoneum on the superior surface of the transverse colon and the anterior layer of the transverse mesocolon before arriving at the posterior abdominal wall.

The lesser omentum is considerably smaller and extends from the lesser curvature of the stomach and the first part of the duodenum to the inferior surface of the liver.

The greater omentum is often referred to as the 'policeman of the abdomen' because of its apparent ability to migrate to any inflamed area and wrap itself around the organ to wall off inflammation. The greater omentum is also an important site for metastatic tumour spread; direct omental spread by a transcoelomic route is common for carcinoma of the ovary.

Mesenteries

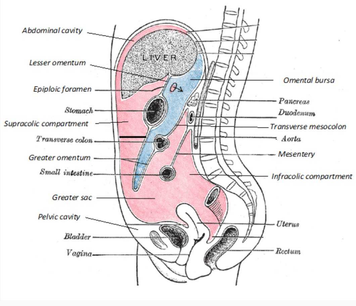
Mesenteries are peritoneal folds that attach viscera to the posterior abdominal wall. They allow some movement and provide a conduit for vessels, nerves and lymphatics to reach the viscera and include:

- the mesentery – associated with parts of the small intestine
- the transverse mesocolon – associated with transverse colon
- the sigmoid mesocolon – associated with the sigmoid colon.

The mesentery is a large, fan-shaped, double-layered fold of peritoneum that connects the jejunum and ileum to the posterior abdominal wall. Its superior attachment is at the duodenojejunal junction, just to the left of the upper lumbar part of the vertebral column. It passes obliquely downwards and to the right, ending at the ileocaecal junction near the upper border of the right sacroiliac joint.

The transverse mesocolon is a fold of peritoneum that connects the transverse colon to the posterior abdominal wall. It leaves the posterior abdominal wall across the anterior surface of the head and body of the pancreas and passes outwards to surround the transverse colon. Its anterior layer is adherent to the posterior layer of the greater omentum.

The sigmoid mesocolon is an inverted V-shaped peritoneal fold that attaches the sigmoid colon to the abdominal wall. The apex of the V is near the division of the left common iliac artery, with the left limb of the descending V along the medial border of the left psoas major muscle, and the right limb descending into the pelvis to end at the level of vertebra S3.



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Anatomy: Abdomen



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McBurney's point, the surface projection of the base of the appendix is located at which of the following sites:

a At the junction of the lateral and middle one-thirds of a line extending from the anterior superior iliac spine to the umbilicus.

b At the midpoint of a line extending from the anterior superior iliac spine to the umbilicus.

c At the junction of the medial and middle one-thirds of a line extending from the anterior superior iliac spine to the umbilicus.

d At the midpoint of a line extending from the anterior superior iliac spine to the pubic symphysis.

e At the midpoint of a line extending from the anterior superior iliac spine to the pubic tubercle.

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Anatomy: Abdomen

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McBurney's point, the surface projection of the base of the appendix is located at which of the following sites:

a)
At the junction of the lateral and middle one-thirds of a line extending from the anterior superior iliac spine to the umbilicus.

b) At the midpoint of a line extending from the anterior superior iliac spine to the umbilicus.

c)
At the junction of the medial and middle one-thirds of a line extending from the anterior superior iliac spine to the umbilicus.

d) At the midpoint of a line extending from the anterior superior iliac spine to the pubic symphysis.

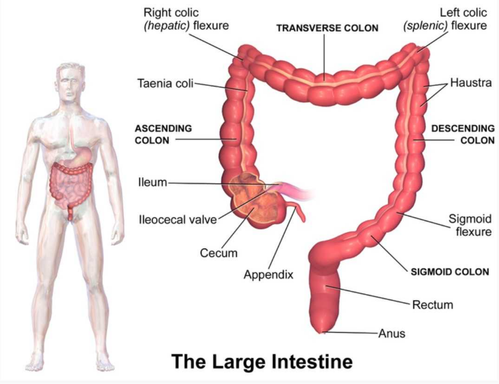
e) At the midpoint of a line extending from the anterior superior iliac spine to the pubic tubercle.

Answer

The surface projection of the base of the appendix is at the junction of the lateral and middle one-third of a line from the anterior superior iliac spine to the umbilicus (McBurney's point). People with appendicitis may describe pain at this location.

Notes

The large intestine extends from the distal end of the ileum to the anus, and comprises the caecum, appendix, colon, rectum and anal canal.



Blausen.com staff. "Blausen gallery 2014". Wikiversity Journal of Medicine. DOI:10.15347/wjm/2014.010. ISSN 20018762. (Own work) [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons

Caecum

The intraperitoneal caecum is the first part of the large intestine. It is inferior to the ileocaecal opening and lies in the right iliac fossa. The caecum is continuous with the ascending colon at the entrance of the ileum and is usually in contact with the anterior abdominal wall. It may cross the pelvic brim to lie in the true pelvis.

Appendix

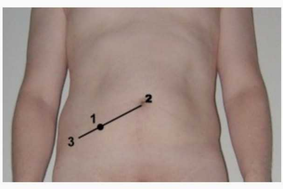
The appendix is attached to the posteromedial wall of the caecum, just inferior to the end of the ileum. The appendix is a narrow, hollow, blind-ended tube. It has large aggregations of lymphoid tissue in its walls and is suspended from the terminal ileum by the mesoappendix.

Its point of attachment to the caecum is consistent with the highly visible free taeniae leading directly to the base of the appendix but the rest of its location is highly variable. It may be:

- 1) posterior to the caecum or the lower ascending colon, or both, in a retrocaecal or retrocolic position
- 2) suspended over the pelvic brim in a pelvic or descending position
- 3) below the caecum in a subcaecal position
- 4) anterior to the terminal ileum, possibly contacting with the body wall in a pre-ileal position or posterior to the terminal ileum in a post-ileal position.

The most common position is retrocaecal, followed by pelvic. The retrocaecal appendix is related anteriorly to the caecum and posteriorly to the psoas major and iliacus muscle. The psoas sign may be positive in retrocaecal appendicitis. Irritation of the psoas muscle (hip flexor) gives rise to pain when the patient's right thigh is extended from a flexed position as the muscle is stretched.

The surface projection of the base of the appendix is at the junction of the lateral and middle one-third of a line from the anterior superior iliac spine to the umbilicus (McBurney's point). People with appendicitis may describe pain at this location.



(1 = McBurney's point, 2 = Umbilicus, 3 = ASIS) By Steven Fruitsmaak [GFDL (http://www.gnu.org/copyleft/fdl.html) or CC-BY-SA-3.0 (http://creativecommons.org/licenses/by-sa/3.0/)], via Wikimedia Commons

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Anatomy: Abdomen



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The lymphatic supply of the liver primarily drains into:

a Superior mesenteric lymph nodes

b Inferior mesenteric lymph nodes

c Coeliac lymph nodes

d Lumbar lymph nodes

e Lateral aortic lymph nodes

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Anatomy: Abdomen

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The lymphatic supply of the liver primarily drains into:

a) **Superior mesenteric lymph nodes** ✗
b) Inferior mesenteric lymph nodes
c) Coeliac lymph nodes ✓
d) Lumbar lymph nodes
e) Lateral aortic lymph nodes

Answer

The lymphatic vessels of the liver drain into hepatic lymph nodes which empty in the coeliac lymph nodes.

Notes

The liver is the largest visceral organ in the body and is primarily located in the right hypochondrium and epigastric region, extending into the left hypochondrium.

Surface marking

Most of the liver is under the right dome of the diaphragm and deep to the lower thoracic wall. The inferior margin of the liver can be palpated descending below the right costal margin on deep inspiration.

The inferior margin is indicated by a line that joins points at the right tenth costal cartilage in the midaxillary line, the tip of the right ninth costal cartilage, the transpyloric plane in the midline, the tip of the left eighth costal cartilage and the left fifth rib in the midclavicular line.

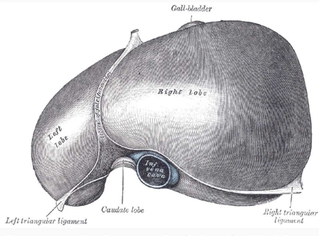
The superior margin is indicated by a line that joints a point on the left fifth rib at the midclavicular line to a corresponding point on the right side. The superior margin is concave in its central part and crosses behind the xiphisternal joint.

Anatomical surfaces

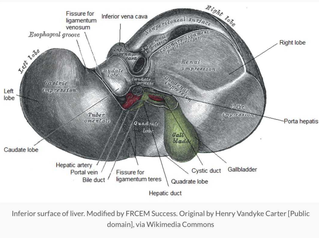
The liver has a diaphragmatic surface in the anterior, superior, and posterior directions and a visceral surface in the inferior direction.

The diaphragmatic surface of the liver is related anteriorly to the anterior abdominal wall and rib cage and superiorly to the diaphragm.

The visceral surface of the liver is related to the oesophagus, right anterior part of the stomach, superior part of the duodenum, lesser omentum, gallbladder, right colic flexure, right transverse colon, right kidney and right adrenal gland.



Diaphragmatic surface of liver. By Henry Vandyke Carter [Public domain], via Wikimedia Commons



Inferior surface of liver. Modified by FRCEM Success. Original by Henry Vandyke Carter [Public domain], via Wikimedia Commons

Lobes

There are four anatomical lobes to the liver.

- The liver is divided into the left and right lobe by the fossae for the gallbladder and the inferior vena cava.
- The caudate lobe sits between the fissure for the ligamentum venosum and the inferior vena cava.
- The quadrate lobe is located between the gallbladder and the fissure for the ligamentum teres.

The porta hepatis is the central intraperitoneal fissure of the liver that separates the caudate and the quadrate lobes. The porta hepatis serves as the point of entry into the liver for the hepatic arteries and portal vein, and the exit point for the hepatic ducts.

Liver lobules

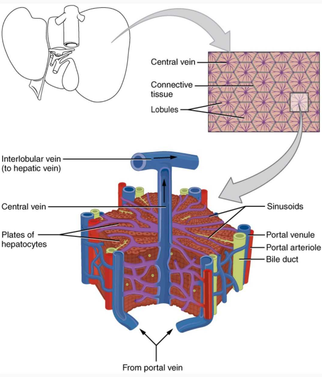
Microscopically, hepatocytes are arranged into lobules which are the functional units of the liver. Each lobule is hexagonal-shaped, and is drained by a venule in its centre, called a central vein (which drains to the hepatic vein).

At the periphery of the hexagon are three structures collectively known as the portal triad, comprising:

- a portal arteriole (a branch of the hepatic artery),
- a portal venule (a branch of the hepatic portal vein),
- a bile duct.

The portal triad also contains lymphatic vessels and vagal parasympathetic nerve fibres.

The liver sinusoids serve as a location for mixing of the oxygen-rich blood from the hepatic artery and the nutrient-rich blood from the portal vein.



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Blood supply

The liver has a unique dual blood supply. The arterial supply to the liver is from the left and right hepatic arteries derived from the hepatic artery proper, a branch of the common hepatic artery from the coeliac trunk.

The hepatic portal vein (formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2) supplies the liver with deoxygenated blood carrying nutrients absorbed from the small intestine.

Venous drainage of the liver is achieved through three hepatic veins, which return the venous blood to the inferior vena cava just inferior to the diaphragm.

Lymphatic drainage

The lymphatic vessels of the liver drain into hepatic lymph nodes which empty in the coeliac lymph nodes.

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Anatomy: Abdomen



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The supraduodenal region of the common bile duct:

a lies superior to the cystic duct.

b lies in the free margin of the greater omentum.

c lies to the left of the hepatic artery proper.

d lies anterior to the portal vein.

e empties into the major duodenal papilla.

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Anatomy: Abdomen

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The supraduodenal region of the common bile duct:

a) lies superior to the cystic duct. ✖
b) lies in the free margin of the greater omentum.
c) lies to the left of the hepatic artery proper.
d) lies anterior to the portal vein. ✔
e) empties into the major duodenal papilla.

Answer

The common bile duct is formed by the union of the common hepatic duct and the cystic duct. The supraduodenal region is the upper one-third of the common bile duct which lies in the free margin of the lesser omentum with the hepatic artery and portal vein. The common bile duct lies anterior to the portal vein and to the right of the hepatic artery proper.

Notes

Biliary tree

The biliary tree begins in the liver parenchyma with the formation of the left and right hepatic duct which drain bile from the liver where it has been synthesised. These two ducts meet to form the common hepatic duct which runs near the liver, with the hepatic artery proper and portal vein in the free margin of the lesser omentum.

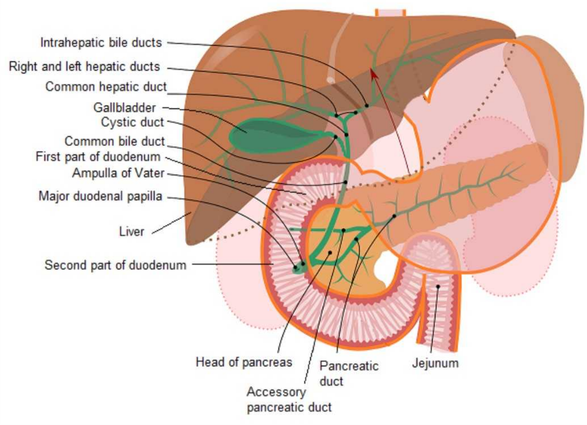
As the common hepatic duct descends, it is joined by the cystic duct, which is a continuation of the neck of the gallbladder. The common hepatic duct and the cystic duct combine to form the common bile duct. At this point the bile duct lies to the right of the hepatic artery proper and usually to the right of, and anterior to, the portal vein in the free margin of the lesser omentum.

As the common bile duct descends, it passes posterior to the first part of the duodenum before joining with the pancreatic duct from the pancreas, forming the hepatopancreatic ampulla (ampulla of Vater) at the major duodenal papilla, located in the second part of the duodenum. Surrounding the ampulla is the sphincter of Oddi, a collection of smooth muscle which can open to allow bile and pancreatic fluid to empty into the duodenum.

Common bile duct relations

The common bile duct can be divided into three main regions, based on its relation to the duodenum:

- The supraduodenal region is the upper one-third which lies in the free margin of the lesser omentum with the hepatic artery and portal vein. The common bile duct lies anterior to the portal vein and to the right of the hepatic artery proper.
- The retroduodenal region is the middle one-third which lies posterior to the first part of the duodenum. The gastroduodenal artery lies on its left aspect and the portal vein on its posterior aspect.
- The infraduodenal region is the lower one-third which lies in a groove on the posterior surface of the head of the pancreas, to the left of the second part of the duodenum and anterior to the right renal vein and inferior vena cava.



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Anatomy: Abdomen



Question 107 of 125

A 45 year old overweight patient presents to ED complaining of fever and severe right upper quadrant pain. The pain radiates to her right shoulder tip. Murphy's sign is positive and you diagnose acute cholecystitis. Which of the following nerves is responsible for the pain referred to the shoulder tip:

a Vagus nerve

b Phrenic nerve

c Greater thoracic splanchnic nerve

d Intercostal nerves

e Lesser thoracic splanchnic nerve

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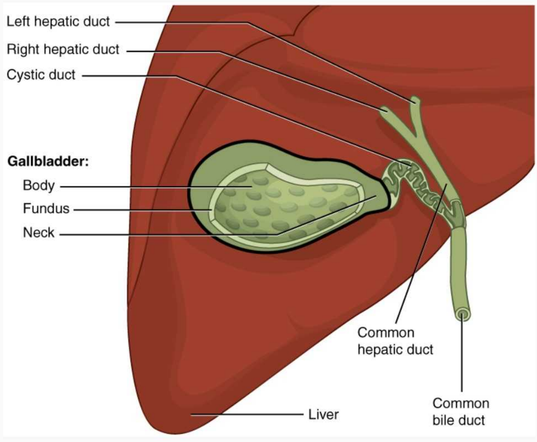
a) Vagus nerve ✗
b) Phrenic nerve ✓
c) Greater thoracic splanchnic nerve
d) Intercostal nerves
e) Lesser thoracic splanchnic nerve

Answer

Inflammation of the gallbladder may present with pain in the right upper quadrant and also the right shoulder; this is due to irritation of the diaphragmatic visceral peritoneum innervated by the phrenic nerve (C3 – C5) that also innervates skin over the shoulder.

Notes

The gallbladder is a pear-shaped sac lying on the visceral surface of the right lobe of the liver in a fossa between the right and quadrate lobes. It is an intraperitoneal structure and lies in the right hypochondrium. It is located at the junction of the right ninth costal cartilage and the lateral border of the rectus abdominis muscle which is the site of maximal tenderness in the acute inflammation of the gallbladder.



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Structure

It has:

- a rounded end, the fundus, which may project from the inferior border of the liver
- a major part in the fossa, the body, which may lie against the transverse colon and the superior part of the duodenum
- and a narrow part, the neck, which tapers to become continuous with the cystic duct.

The neck contains a mucosal fold, known as Hartmann's pouch, which is a common site for gallstones to become lodged.

Relations

The gallbladder lies:

- posterior and inferior to the liver
- posterior to the anterior abdominal wall
- anterior to the transverse colon and the proximal duodenum
- superior to the biliary tree and the duodenum.

Innervation

Inflammation of the gallbladder may present with pain in the right upper quadrant and also the right shoulder; this is due to irritation of the diaphragmatic visceral peritoneum innervated by the phrenic nerve (C3 – C5) that also innervates skin over the shoulder.

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Anatomy: Abdomen



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The rectus sheath encloses all of the following structures except the:

a Transversus abdominis muscle

b Pyramidalis muscle

c Lower thoracic intercostal nerves

d Superior epigastric artery

e Inferior epigastric artery

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The rectus sheath encloses all of the following structures except the:

a) **Transversus abdominis muscle** ✔
b) Pyramidalis muscle
c) Lower thoracic intercostal nerves
d) Superior epigastric artery
e) Inferior epigastric artery

Answer

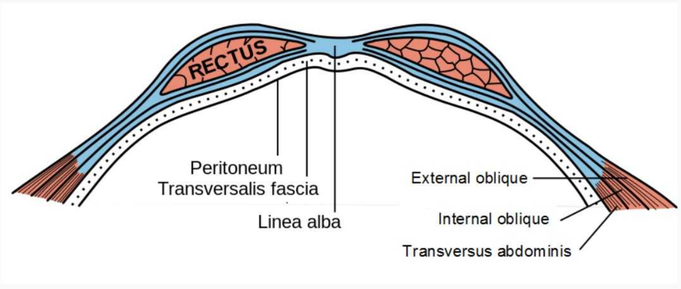
The rectus sheath encloses the rectus abdominis and pyramidalis muscles, the superior and inferior epigastric vessels, the termination of intercostal nerves T7 – T11 and the 12th thoracic nerve and the accompanying vessels.

Notes

The rectus sheath is formed by the aponeuroses of the three flat anterior abdominal wall muscles.

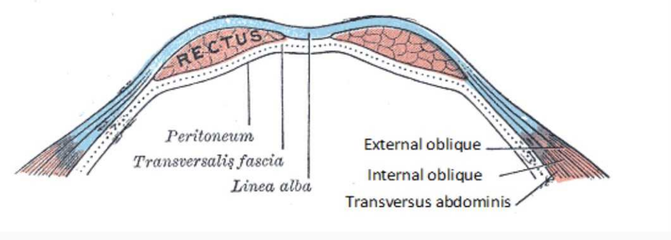
The anterior wall of the sheath is formed by the aponeurosis of the external oblique and half of the aponeurosis of the internal oblique (which splits at the lateral margin of the rectus abdominis).

The posterior wall of the sheath is formed by the other half of the aponeurosis of the internal oblique and by the aponeurosis of the transversus abdominis.



By Henry Vandyke Carter [Public domain], via Wikimedia Commons

The rectus sheath completely encloses the upper three-quarters of the rectus abdominis in the above formation but only covers the anterior surface of the lower one-quarter of the muscle. At this point (midway between the umbilicus and the pubic symphysis), the anterior wall is formed by the aponeuroses of all three muscles, there is no posterior wall to the rectus sheath and the rectus abdominis muscle is in direct contact with the transversalis fascia. Marking this point of transition is the arcuate line.



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The rectus sheath also encloses the pyramidalis muscle, the superior and inferior epigastric vessels, the termination of intercostal nerves T7 – T11 and the 12th thoracic nerve and the accompanying vessels.

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Anatomy: Abdomen



Question 109 of 125

Control of bile and pancreatic fluid entering the duodenum is regulated by the:

a Ampulla of Vater

b Major duodenal papilla

c External biliary sphincter

d Internal biliary sphincter

e Sphincter of Oddi

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Control of bile and pancreatic fluid entering the duodenum is regulated by the:

a) Ampulla of Vater ✖
b) Major duodenal papilla
c) External biliary sphincter
d) Internal biliary sphincter
e) Sphincter of Oddi ✔

Answer

As the common bile duct descends, it passes posterior to the first part of the duodenum before joining with the pancreatic duct from the pancreas, forming the hepatopancreatic ampulla (ampulla of Vater) at the major duodenal papilla, located in the second part of the duodenum. Surrounding the ampulla is the sphincter of Oddi, a collection of smooth muscle which can open to allow bile and pancreatic fluid to empty into the duodenum.

Notes

Biliary tree

The biliary tree begins in the liver parenchyma with the formation of the left and right hepatic duct which drain bile from the liver where it has been synthesised. These two ducts meet to form the common hepatic duct which runs near the liver, with the hepatic artery proper and portal vein in the free margin of the lesser omentum.

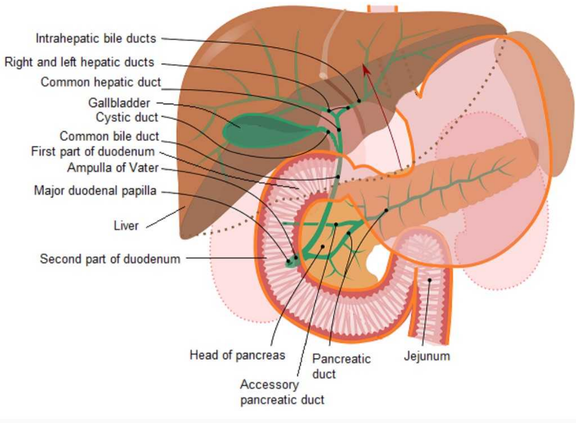
As the common hepatic duct descends, it is joined by the cystic duct, which is a continuation of the neck of the gallbladder. The common hepatic duct and the cystic duct combine to form the common bile duct. At this point the bile duct lies to the right of the hepatic artery proper and usually to the right of, and anterior to, the portal vein in the free margin of the lesser omentum.

As the common bile duct descends, it passes posterior to the first part of the duodenum before joining with the pancreatic duct from the pancreas, forming the hepatopancreatic ampulla (ampulla of Vater) at the major duodenal papilla, located in the second part of the duodenum. Surrounding the ampulla is the sphincter of Oddi, a collection of smooth muscle which can open to allow bile and pancreatic fluid to empty into the duodenum.

Common bile duct relations

The common bile duct can be divided into three main regions, based on its relation to the duodenum:

- The first supraduodenal region is the upper one-third which lies in the free margin of the lesser omentum with the hepatic artery and portal vein. The common bile duct lies anterior to the portal vein and to the right of the hepatic artery proper.
- The second retroduodenal region is the middle one-third which lies posterior to the first part of the duodenum. The gastroduodenal artery lies on its left aspect and the portal vein on its posterior aspect.
- The third infraduodenal region is the lower one-third which lies in a groove on the posterior surface of the head of the pancreas, to the left of the second part of the duodenum and anterior to the right renal vein and inferior vena cava.



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Anatomy: Abdomen



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The arterial supply to the pancreas is mainly derived from which of the following:

a Gastric artery

b Splenic artery

c Hepatic artery

d Renal artery

e Inferior mesenteric artery

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Anatomy: Abdomen



Question 110 of 125

The arterial supply to the pancreas is mainly derived from which of the following:

a) Gastric artery
b) **Splenic artery** ✔
c) Hepatic artery
d) Renal artery
e) Inferior mesenteric artery

The pancreas lies mostly posterior to the stomach. It extends across the posterior abdominal wall from the duodenum on the right, to the spleen on the left. It lies in the epigastrium and left hypochondrium regions. The pancreas is a retroperitoneal organ (except for a small part of its tail) and consists of a head, uncinate process, neck, body and tail.

The head of the pancreas lies within the C-shaped concavity of the duodenum. The uncinate process projects from the lower part of the head and passes posterior to the superior mesenteric vessels. The neck is anterior to the superior mesenteric vessels. Posterior to the neck of the pancreas, the superior mesenteric and splenic veins join to form the portal vein. The body is elongated and extends from the neck to the tail of the pancreas in the transpyloric plane (at the level of vertebra L1) to lie behind the stomach and to the left of the superior mesenteric vessels. The tail passes between layers of the splenorenal ligament (intraperitoneal) and lies medial to the spleen.

The pancreatic duct begins in the tail of the pancreas and passes to the right through the body and to the head where it turns inferiorly and joins the bile duct forming the ampulla of Vater which enters the second part of the duodenum at the major duodenal papilla. The accessory pancreatic duct empties into the duodenum just above the major duodenal papilla at the minor duodenal papilla.

The arterial supply to the pancreas is mainly by pancreatic branches derived from the splenic artery (branch of the coeliac trunk). The head is additionally supplied by branches of the gastroduodenal and superior mesenteric arteries. Venous drainage of the head of the pancreas is via pancreaticoduodenal veins into the superior mesenteric vein and portal vein; venous drainage of the body and tail of the pancreas is via pancreatic veins into the splenic vein.

Lymphatic drainage is to the coeliac group of pre-aortic nodes.

The sympathetic nerve supply is derived from the T6 – T10 spinal cord segments and thus pain is typically referred to the lower thorax and epigastric region.

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Anatomy: Abdomen



Question 111 of 125

The fourth part of the duodenum terminates at which of the following vertebral levels:

a T12

b L1

c L2

d L3

e L4

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The fourth part of the duodenum terminates at which of the following vertebral levels:

a) T12
b) L1
c) L2 ✔
d) L3
e) L4

Answer

The ascending (fourth) part passes upwards on, or to the left of the aorta to approximately the upper border of vertebra L2 and terminates at the duodenojejunal flexure.

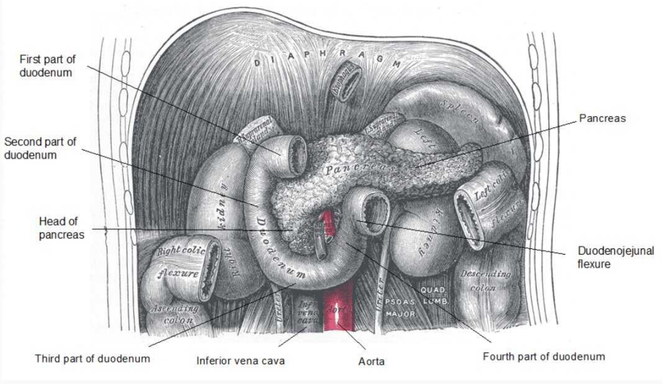
Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum. The first part of the small intestine is the duodenum.

The duodenum is a C-shaped structure, adjacent to the head of the pancreas, and above the level of the umbilicus. It is retroperitoneal except for its proximal part which is connected to the liver by the hepatoduodenal ligament of the lesser omentum.

Parts of the duodenum

- The superior (first) part extends from the pyloric orifice of the stomach to the neck of the gallbladder, lies just to the right of the body of vertebra L1, and passes anterior to the inferior vena cava and superior to the head of the pancreas.
- The descending (second) part is just to the right of the midline, extending from the neck of the gallbladder to the lower border of vertebra L3 and lying lateral to the head of the pancreas. This part contains the major duodenal papilla which is the common entrance for the bile and pancreatic ducts.
- The inferior (third) part is the longest section, crossing the inferior vena cava, the aorta and the vertebral column at the level of vertebra L3 and lying inferior to the pancreas.
- The ascending (fourth) part passes upwards on, or to the left of the aorta to approximately the upper border of vertebra L2 and terminates at the duodenojejunal flexure.



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Blood supply

The arterial supply of the duodenum is primarily from the pancreaticoduodenal arteries, branches of the superior mesenteric artery and the gastroduodenal artery (branch of the common hepatic artery from the coeliac trunk).

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Anatomy: Abdomen



Question 112 of 125

Irritation of the central part of the diaphragmatic peritoneum is typically referred to:

a The jaw

b The shoulder tip

c The epigastric region

d The periumbilical region

e The flanks

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Anatomy: Abdomen

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Irritation of the central part of the diaphragmatic peritoneum is typically referred to:

a) The jaw ✗
b) The shoulder tip ✓
c) The epigastric region
d) The periumbilical region
e) The flanks

Answer

The diaphragmatic peritoneum is supplied by the phrenic nerve (C3 – C5) and thus painful stimuli to the diaphragmatic peritoneum can be referred to the shoulder tip.

Notes

The peritoneum is a continuous double-layered serous membrane.

The parietal peritoneum lines the walls of the abdominal cavity and the visceral peritoneum lines the viscera.

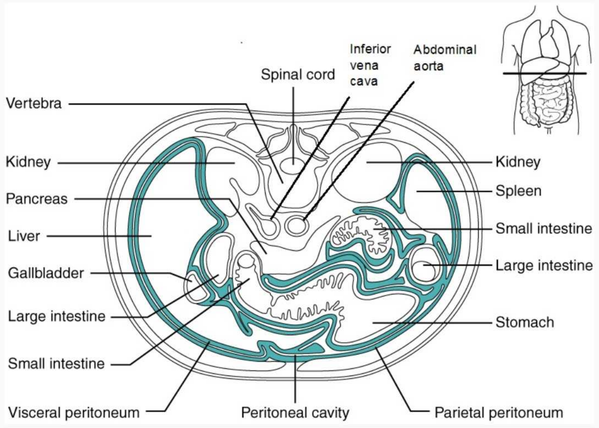
Between the parietal and visceral layers of peritoneum is a potential space, the peritoneal cavity.

Abdominal viscera are either suspended in the peritoneal cavity by folds of peritoneum called mesenteries (intraperitoneal viscera) or are outside the peritoneal cavity bound to the posterior abdominal wall (retroperitoneal viscera). Retroperitoneal organs are only covered in peritoneum on their anterior surface.

Innervation

The parietal peritoneum associated with the abdominal wall is innervated by somatic afferents carried in branches of the associated spinal nerves and is therefore sensitive to pressure, pain and temperature, and gives rise to well-localised pain. The diaphragmatic peritoneum is supplied by the phrenic nerve (C3 – C5) and the remainder of the parietal peritoneum is supplied segmentally by intercostal and lumbar nerves.

The visceral peritoneum is innervated by visceral afferents that accompany autonomic nerves back to the CNS and therefore activation gives rise to referred and poorly localised sensations of discomfort and to visceral motor activity.



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Retroperitoneal viscera

A useful mnemonic to help remember which abdominal organs are retroperitoneal is SAD PUCKER:

- Suprarenal glands
- Aorta and Inferior vena cava
- Duodenum (2nd and 3rd parts)
- Pancreas (except for the tail)
- Ureters (proximal) and Bladder
- Colon (ascending and descending)
- Kidneys
- (O)esophagus
- Rectum (lower two-thirds)

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Anatomy: Abdomen



Question 113 of 125

The common bile duct drains into the duodenum in which of the following regions:

a First part of the duodenum

b Duodenojejunal flexure

c Second part of the duodenum

d Third part of the duodenum

e Fourth part of the duodenum

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The common bile duct drains into the duodenum in which of the following regions:

a) **First part of the duodenum** ✗
b) Duodenojejunal flexure
c) Second part of the duodenum ✓
d) Third part of the duodenum
e) Fourth part of the duodenum

Answer

As the common bile duct descends, it passes posterior to the first part of the duodenum before joining with the pancreatic duct from the pancreas, forming the hepatopancreatic ampulla (ampulla of Vater) at the major duodenal papilla, located in the second part of the duodenum.

Notes

Biliary tree

The biliary tree begins in the liver parenchyma with the formation of the left and right hepatic duct which drain bile from the liver where it has been synthesised. These two ducts meet to form the common hepatic duct which runs near the liver, with the hepatic artery proper and portal vein in the free margin of the lesser omentum.

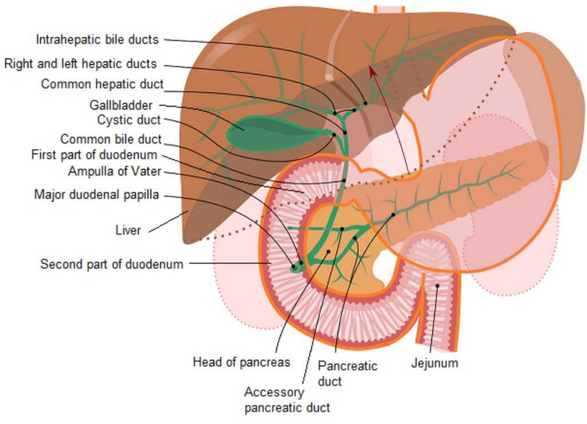
As the common hepatic duct descends, it is joined by the cystic duct, which is a continuation of the neck of the gallbladder. The common hepatic duct and the cystic duct combine to form the common bile duct. At this point the bile duct lies to the right of the hepatic artery proper and usually to the right of, and anterior to, the portal vein in the free margin of the lesser omentum.

As the common bile duct descends, it passes posterior to the first part of the duodenum before joining with the pancreatic duct from the pancreas, forming the hepatopancreatic ampulla (ampulla of Vater) at the major duodenal papilla, located in the second part of the duodenum. Surrounding the ampulla is the sphincter of Oddi, a collection of smooth muscle which can open to allow bile and pancreatic fluid to empty into the duodenum.

Common bile duct relations

The common bile duct can be divided into three main regions, based on its relation to the duodenum:

- The first supraduodenal region is the upper one-third which lies in the free margin of the lesser omentum with the hepatic artery and portal vein. The common bile duct lies anterior to the portal vein and to the right of the hepatic artery proper.
- The second retroduodenal region is the middle one-third which lies posterior to the first part of the duodenum. The gastroduodenal artery lies on its left aspect and the portal vein on its posterior aspect.
- The third infraduodenal region is the lower one-third which lies in a groove on the posterior surface of the head of the pancreas, to the left of the second part of the duodenum and anterior to the right renal vein and inferior vena cava.



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The infraduodenal region of the common bile duct:

a runs in a groove posterior to the head of the pancreas.

b lies posterior to the first part of the duodenum.

c lies posterior to the inferior vena cava.

d lies anterior to the left renal vein.

e empties into the third part of the duodenum.

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The infraduodenal region of the common bile duct:

a) **runs in a groove posterior to the head of the pancreas.** ✔
b) lies posterior to the first part of the duodenum.
c) lies posterior to the inferior vena cava.
d) lies anterior to the left renal vein.
e) empties into the third part of the duodenum.

Answer

The infraduodenal region is the lower one-third of the common bile duct which lies in a groove on the posterior surface of the head of the pancreas, to the left of the second part of the duodenum and anterior to the right renal vein and inferior vena cava.

Notes

Biliary tree

The biliary tree begins in the liver parenchyma with the formation of the left and right hepatic duct which drain bile from the liver where it has been synthesised. These two ducts meet to form the common hepatic duct which runs near the liver, with the hepatic artery proper and portal vein in the free margin of the lesser omentum.

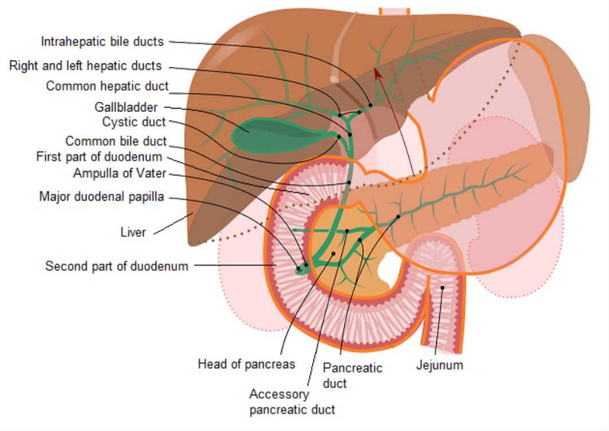
As the common hepatic duct descends, it is joined by the cystic duct, which is a continuation of the neck of the gallbladder. The common hepatic duct and the cystic duct combine to form the common bile duct. At this point the bile duct lies to the right of the hepatic artery proper and usually to the right of, and anterior to, the portal vein in the free margin of the lesser omentum.

As the common bile duct descends, it passes posterior to the first part of the duodenum before joining with the pancreatic duct from the pancreas, forming the hepatopancreatic ampulla (ampulla of Vater) at the major duodenal papilla, located in the second part of the duodenum. Surrounding the ampulla is the sphincter of Oddi, a collection of smooth muscle which can open to allow bile and pancreatic fluid to empty into the duodenum.

Common bile duct relations

The common bile duct can be divided into three main regions, based on its relation to the duodenum:

- The supraduodenal region is the upper one-third which lies in the free margin of the lesser omentum with the hepatic artery and portal vein. The common bile duct lies anterior to the portal vein and to the right of the hepatic artery proper.
- The retroduodenal region is the middle one-third which lies posterior to the first part of the duodenum. The gastroduodenal artery lies on its left aspect and the portal vein on its posterior aspect.
- The infraduodenal region is the lower one-third which lies in a groove on the posterior surface of the head of the pancreas, to the left of the second part of the duodenum and anterior to the right renal vein and inferior vena cava.



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Anatomy: Abdomen



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The greater sac of the peritoneal cavity is divided into two compartments by which of the following structures:

a Liver

b Stomach

c Transverse mesocolon

d Duodenum

e Mesentery

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Anatomy: Abdomen

Question 115 of 125

The greater sac of the peritoneal cavity is divided into two compartments by which of the following structures:

a) Liver ✗
b) Stomach
c) Transverse mesocolon ✓
d) Duodenum
e) Mesentery

Answer

The greater sac accounts for most of the space in the peritoneal cavity, beginning superiorly at the diaphragm and continuing inferiorly in the pelvic cavity. It is further divided into two compartments by the transverse mesocolon, the supracolic and infracolic compartments.

Notes

Structure	Key anatomy
Peritoneal cavity	Divided into greater and lesser sacs
Greater sac	Divided into supracolic and infracolic compartments by transverse mesocolon, compartments connected by paracolic gutters
Supracolic compartment	Contains stomach, liver and spleen, lies under cover of costal limits of thoracic cage
Infracolic compartment	Divided into left and right parts by oblique attachment of mesentery, contains small intestine and ascending/descending colon, continuous with pelvic cavity
Lesser sac (omental bursa	Lies posterior to stomach and liver and anterior to pancreas, continuous with greater sac through epiploic foramen
Greater omentum	Descends from greater curvature of stomach and first part of duodenum, drapes inferiorly over transverse colon, jejunum and ileum, folds back up and ascends to adhere to transverse colon/mesocolon before arriving at posterior abdominal wall
Lesser omentum	Extends from lesser curvature of stomach and first part of duodenum to inferior surface of liver
Mesentery	Connects jejunum and ileus to posterior abdominal wall, attaches superiorly to duodenojejunal junction and passes oblique downwards and to the right to end at ileocecal junction
Transverse mesocolon	Connects transverse colon to posterior abdominal wall, leaves posterior abdominal wall across anterior surface of head and body of pancreas and passes outwards to surround transverse colon
Sigmoid mesocolon	Connects sigmoid colon to abdominal wall, V-shaped fold with apex near division of left common iliac artery, left limb descending along medial border of left psoas major muscle and right limb descending into pelvis to end at vertebral level S3

Compartments of the peritoneal cavity

The peritoneal cavity is divided into the greater sac and the omental bursa (lesser sac).

The greater sac accounts for most of the space in the peritoneal cavity, beginning superiorly at the diaphragm and continuing inferiorly in the pelvic cavity. It is further divided into two compartments by the transverse mesocolon:

- The supracolic compartment lies above the transverse mesocolon and contains the stomach, liver and spleen. It lies largely under cover of the costal limits of the thoracic cage.
- The infracolic compartment lies below the transverse mesocolon, is divided into left and right parts by the oblique attachment of the mesentery and contains the small intestine and the ascending and descending colon. The left infracolic compartment is continuous with the pelvic cavity.

The supracolic and infracolic compartments are connected by the paracolic gutters which lie between the posterolateral abdominal wall and the lateral aspect of the ascending or descending colon.

The omental bursa (lesser sac) is a smaller subdivision of the peritoneal cavity posterior to the stomach and liver and anterior to the pancreas, and is continuous with the greater sac through the epiploic foramen.

Omenta

The omenta are double layers of peritoneum that extends from the stomach and proximal part of the duodenum to other organs.

The greater omentum descends from the greater curvature of the stomach and first part of the duodenum, drapes inferiorly over the transverse colon and the coils of the jejunum and ileum, then folds back up posteriorly and ascends to become adherent to the peritoneum on the superior surface of the transverse colon and the anterior layer of the transverse mesocolon before arriving at the posterior abdominal wall.

The lesser omentum is considerably smaller and extends from the lesser curvature of the stomach and the first part of the duodenum to the inferior surface of the liver.

The greater omentum is often referred to as the 'policeman of the abdomen' because of its apparent ability to migrate to any inflamed area and wrap itself around the organ to wall off inflammation. The greater omentum is also an important site for metastatic tumour spread; direct omental spread by a transcoelomic route is common for carcinoma of the ovary.

Mesenteries

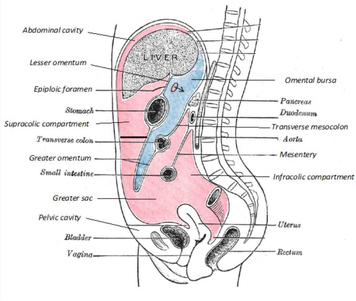
Mesenteries are peritoneal folds that attach viscera to the posterior abdominal wall. They allow some movement and provide a conduit for vessels, nerves and lymphatics to reach the viscera and include:

- the mesentery – associated with parts of the small intestine
- the transverse mesocolon – associated with transverse colon
- the sigmoid mesocolon – associated with the sigmoid colon.

The mesentery is a large, fan-shaped, double-layered fold of peritoneum that connects the jejunum and ileum to the posterior abdominal wall. Its superior attachment is at the duodenojejunal junction, just to the left of the upper lumbar part of the vertebral column. It passes obliquely downwards and to the right, ending at the ileocaecal junction near the upper border of the right sacroiliac joint.

The transverse mesocolon is a fold of peritoneum that connects the transverse colon to the posterior abdominal wall. It leaves the posterior abdominal wall across the anterior surface of the head and body of the pancreas and passes outwards to surround the transverse colon. Its anterior layer is adherent to the posterior layer of the greater omentum.

The sigmoid mesocolon is an inverted V-shaped peritoneal fold that attaches the sigmoid colon to the abdominal wall. The apex of the V is near the division of the left common iliac artery, with the left limb of the descending V along the medial border of the left psoas major muscle, and the right limb descending into the pelvis to end at the level of vertebra S3.



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Anatomy: Abdomen



Question 116 of 125

The anterior abdominal wall muscles are innervated by:

a The anterior rami of L1 – L3

b The anterior rami of T7 – T12 and L1

c The anterior rami of T12 and L1 – L4

d The phrenic nerve

e The anterior rami of T7 – T10

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Anatomy: Abdomen

Question 116 of 125

The anterior abdominal wall muscles are innervated by:

a) The anterior rami of L1 – L3
b) The anterior rami of T7 – T12 and L1 ✔
c) **The anterior rami of T12 and L1 – L4** ✖
d) The phrenic nerve
e) The anterior rami of T7 – T10

Answer

The anterior abdominal wall muscles are innervated by the anterior rami of T7 – T12 and L1.

Notes

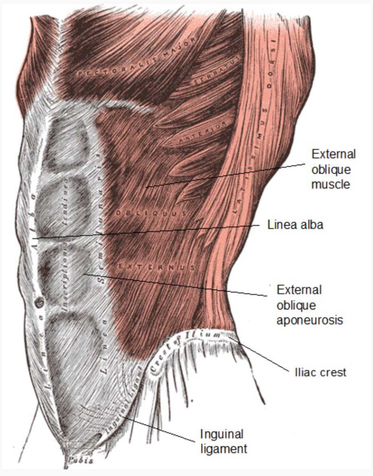
There are five muscles in the anterolateral group of abdominal wall muscles; three flat muscles whose fibres begin posterolaterally and pass anteriorly before being replaced by an aponeurosis as the muscle continues towards the midline (external oblique, internal oblique, transversus abdominis) and two vertical muscles enclosed by the tendinous sheath formed by the aponeuroses of the flat muscles (rectus abdominis, pyramidalis).

External oblique

The external oblique is the largest and most superficial of the anterior abdominal muscles, lying just deep to the superficial fascia. The external oblique originates from the outer surfaces of the lower eight ribs, its fibres running in an inferomedial direction before inserting onto the lateral lip of the iliac crest.

The external oblique has a large aponeurotic component that covers the anterior part of the abdominal wall and forms the linea alba at the midline, together with the aponeuroses from the internal oblique and the transversus abdominis. The linea alba extends from the xiphoid process to the pubic symphysis.

The lower free border of the external oblique aponeurosis forms the inguinal ligament on each side (which runs between the anterior superior iliac spine laterally and the pubic tubercle medially).



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Internal oblique

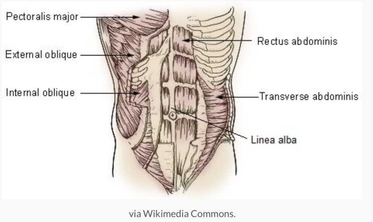
The internal oblique muscle lies deep to the external oblique. Its fibres run in a superomedial direction, originating from the thoracolumbar fascia, the iliac crest and the lateral two-thirds of the inguinal ligament and inserting onto the inferior border of the lower 3 – 4 ribs, the linea alba, the pubic crest and pectineal line.

Transversus abdominis

The transversus abdominis is the innermost of the flat anterior abdominal muscles, lying deep to the internal oblique. It originates from the thoracolumbar fascia, the iliac crest, the lateral one-third of the inguinal ligament and the 7th – 12th costal cartilages and inserts onto the linea alba, the pubic crest and the pectineal line.

Rectus abdominis

The rectus abdominis is a long muscle that extends the length of the anterior abdominal wall. It originates from the pubic crest, pubic tubercle and pubic symphysis and inserts onto the costal cartilages of ribs 5 – 7 and to the xiphoid process. It is a paired muscle, separated in the midline by the linea alba.



via Wikimedia Commons.

Function

The abdominal wall muscles form a firm, but flexible wall that keeps the abdominal viscera within the abdominal cavity, protects the viscera from injury and helps maintain the position of the viscera in the erect posture against the action of gravity.

The muscles act together to flex and rotate the vertebral column.

In addition, contraction of these muscles assists in forced expiration, and in coughing and vomiting, by pushing the viscera upwards. All of these muscles are involved in any action that increases intra-abdominal pressure, including childbirth, micturition and defaecation.

Innervation

The anterior abdominal wall muscles are innervated by the anterior rami of T7 – T12 and L1.

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Anatomy: Abdomen



Question 117 of 125

Visceral afferent fibres from the pancreas travel to which of the following spinal cord levels:

a T1 – T2

b T4 – T6

c T6 – T10

d T10 – T12

e T12 – L2

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Anatomy: Abdomen

Question 117 of 125

Visceral afferent fibres from the pancreas travel to which of the following spinal cord levels:

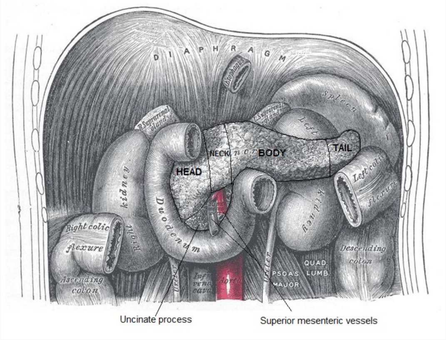
a) T1 – T2 ✗
b) T4 – T6
c) T6 – T10 ✓
d) T10 – T12
e) T12 – L2

Answer

Visceral afferent fibres travel in the greater and lesser splanchnic nerves. The segmental level of innervation is T6 – T10. Pain typically radiates to the middle of the back due to irritation of the parietal peritoneum covering the pancreas.

Notes

The pancreas lies mostly posterior to the stomach. It extends across the posterior abdominal wall from the duodenum on the right, to the spleen on the left. It lies in the epigastric region and left hypochondrium. The pancreas is a retroperitoneal organ (except for a small part of its tail) and consists of a head, uncinate process, neck, body and tail.

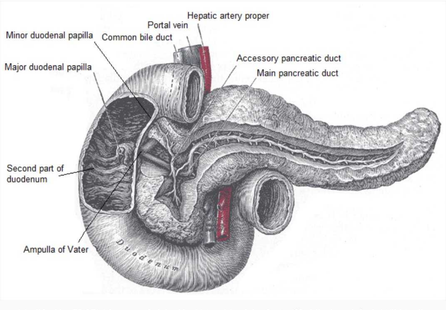


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Relations

- The head of the pancreas lies within the C-shaped concavity of the duodenum. The head is related anteriorly to the first part of the duodenum, the transverse colon and coils of jejunum and posteriorly to the common bile duct and the inferior vena cava and the termination of the renal veins.
- The uncinate process projects from the lower part of the head and passes posterior to the superior mesenteric vessels.
- The neck is anterior to the superior mesenteric vessels. Posterior to the neck of the pancreas, the superior mesenteric and splenic veins join to form the portal vein.
- The body is elongated and extends from the neck to the tail of the pancreas in the transpyloric plane (at the level of vertebra L1) to lie behind the stomach and to the left of the superior mesenteric vessels.
- The intraperitoneal tail passes between layers of the splenorenal ligament. It is related to the left kidney posteriorly, the hilum of the spleen laterally, the left colic flexure inferiorly and the stomach anteriorly.

The pancreatic duct begins in the tail of the pancreas and passes to the right, through the body and to the head where it turns inferiorly and joins the bile duct forming the hepatopancreatic ampulla (ampulla of Vater) which enters the second part of the duodenum at the major duodenal papilla. The accessory pancreatic duct empties into the duodenum just above the major duodenal papilla at the minor duodenal papilla.



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Blood supply

The arterial supply to the pancreas is primarily derived from the splenic artery from the coeliac trunk, assisted by branches from the gastroduodenal artery (from the common hepatic artery from the coeliac trunk), and from the superior mesenteric artery.

Venous drainage of the head of the pancreas is via pancreaticoduodenal veins into the superior mesenteric vein and portal vein. Venous drainage of the body and tail of the pancreas is via pancreatic veins into the splenic vein.

Lymphatics

Lymphatics draining the pancreas empty into the pancreaticosplenic nodes and the pyloric nodes, which in turn drain into the superior mesenteric and celiac pre-aortic lymph nodes.

Innervation

Visceral afferent fibres travel in the greater and lesser splanchnic nerves. The segmental level of innervation is T6 – T10. Pain typically radiates to the middle of the back due to irritation of the parietal peritoneum covering the pancreas.

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Anatomy: Abdomen



Question 118 of 125

The abdominal oesophagus ends at which of the following vertebral levels:

a T8

b T9

c T10

d T11

e T12

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Anatomy: Abdomen



Question 118 of 125

The abdominal oesophagus ends at which of the following vertebral levels:

a) T8 ✗
b) T9
c) T10
d) T11 ✓
e) T12

Answer

The abdominal oesophagus meets the cardiac orifice of the stomach, ending at the level of vertebra T11.

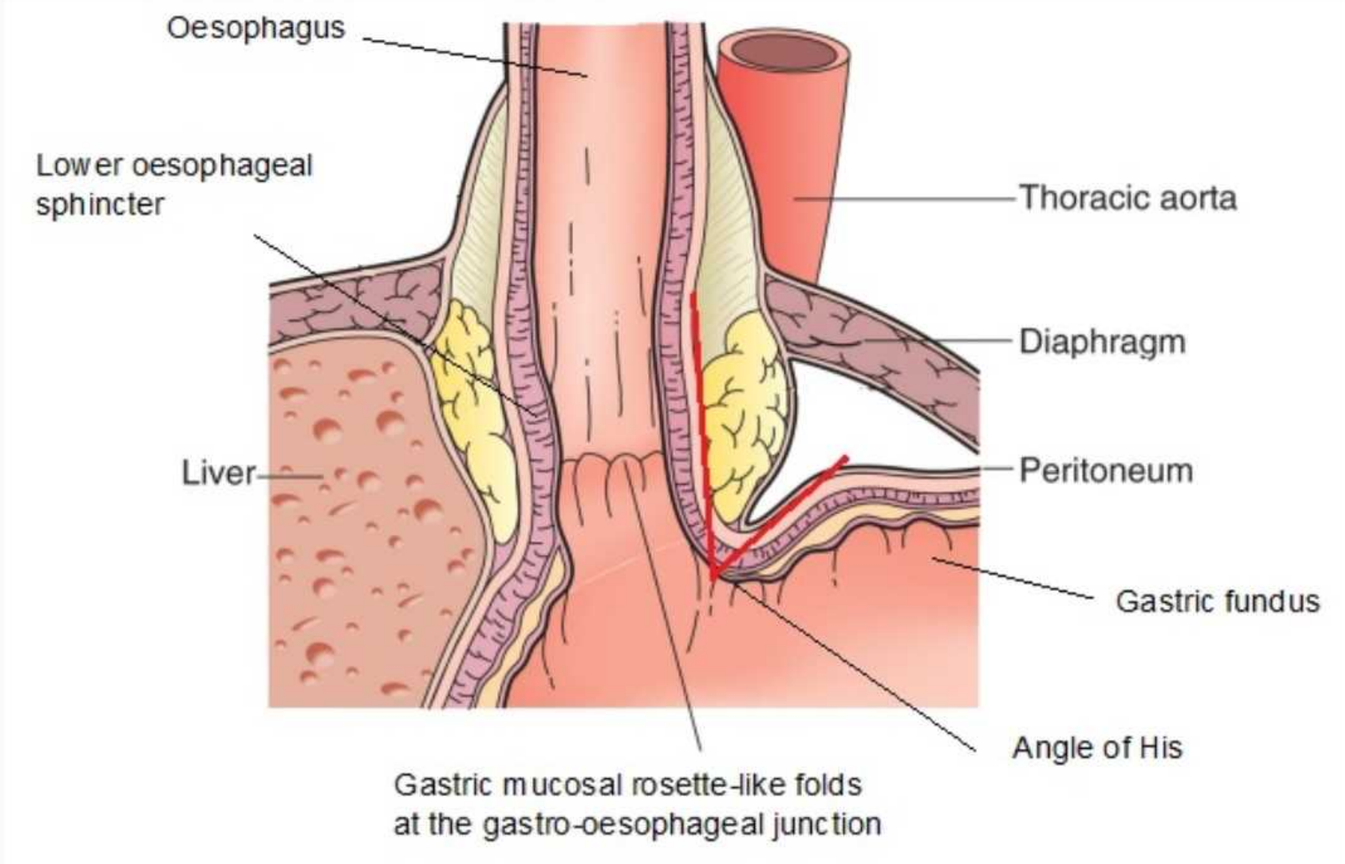
Notes

The abdominal oesophagus represents the short distal part (about 2 cm) of the oesophagus located in the abdominal cavity. Emerging through the right crus of the diaphragm at the level of vertebra T10, it passes from the oesophageal hiatus to the cardiac orifice of the stomach just left of the midline at the level of vertebra T11.

The lower oesophageal sphincter is a physiological sphincter located at the gastro-oesophageal junction.

Anatomical factors that help guard against gastric reflux include:

- The diaphragmatic pinchcock effect where at the oesophageal hiatus, right crural fibres exert pressure on the oesophageal wall and serve as an extrinsic sphincter
- The lower oesophageal sphincter which is a high-pressure zone of smooth muscle in the oesophageal wall maintained in a state of tonic contraction (except during swallowing, belching or vomiting)
- Intra-abdominal pressure which maintains the oesophagus in a state of collapse when empty
- The angle of His formed at the junction of the oesophagus and the gastric fundus, which together with the posterolateral position of the gastric fundus, minimises contact of gastric content with the gastro-oesophageal junction
- The gastric mucosal rosette-like folds formed at the gastro-oesophageal junction which compress against each other with increased intraabdominal pressure to prevent reflux



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Anatomy: Abdomen

Question 119 of 125



A 31 year old man is brought to ED following a road traffic accident in which he was wearing his seatbelt. Imaging shows a fracture of the left ninth and tenth rib with intra-abdominal bleeding. Which of the following organs is most likely injured:

a Liver

b Pancreas

c Spleen

d Left kidney

e Left colic flexure

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Anatomy: Abdomen

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A 31 year old man is brought to ED following a road traffic accident in which he was wearing his seatbelt. Imaging shows a fracture of the left ninth and tenth rib with intra-abdominal bleeding. Which of the following organs is most likely injured:

a) Liver ✖
b) Pancreas
c) Spleen ✔
d) Left kidney
e) Left colic flexure

Answer

The spleen rests against the diaphragm and ribs 9 – 11 in the left hypochondriac region. The left colic flexure lies inferior to the spleen. The left kidney lies retroperitoneally approximately at the level of T11 to L3 vertebra. The liver lies predominantly in the right hypochondrium and epigastrium (although a small portion protrudes into the left hypochondrium below the diaphragm). The body of the pancreas lies in front of the second lumbar vertebra.

Notes

The intraperitoneal spleen lies against the diaphragm, in the area of rib 9 – 11. It lies in the left hypochondrium of the abdomen. The spleen cannot normally be palpated on clinical examination.

The spleen is an organ of the reticuloendothelial system and acts:

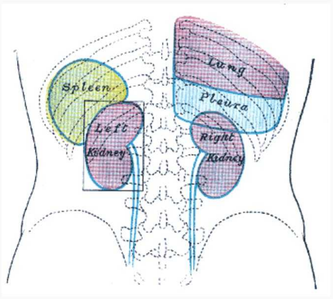
- to filter blood to remove old and defective blood cells
- as a blood reservoir
- to produce white blood cells
- to produce an immune response

Relations

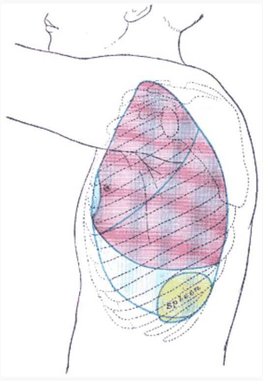
The spleen lies posterior to the stomach, superior to the left colic flexure and laterally to the left kidney and tail of the pancreas.

Surface markings

The spleen projects onto the left side and back in the area of ribs 9 – 11. The spleen follows the contour of rib 10 and extends from the superior pole of the left kidney to just posterior to the midaxillary line.



By Henry Vandyke Carter [Public domain], via Wikimedia Commons



By Henry Vandyke Carter [Public domain], via Wikimedia Commons

Splenic rupture

This most commonly occurs due to localised trauma to the left upper quadrant. It may be associated with left lower rib fractures. Because the spleen has an extremely thin capsule it is susceptible to injury even when there is no damage to surrounding structures and because the spleen is highly vascular, when ruptured, it bleeds profusely into the peritoneal cavity.

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Anatomy: Abdomen



Question 120 of 125

The right and left hepatic arteries are derived from which of the following blood vessels:

a Directly from the aorta

b From the coeliac trunk

c From the superior mesenteric artery

d From the inferior mesenteric artery

e From the gastrosplenic artery

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Anatomy: Abdomen

Question 120 of 125

The right and left hepatic arteries are derived from which of the following blood vessels:

a) **Directly from the aorta** ✗
b) From the coeliac trunk ✓
c) From the superior mesenteric artery
d) From the inferior mesenteric artery
e) From the gastrosplenic artery

Answer

The arterial supply to the liver is from the left and right hepatic arteries derived from the hepatic artery proper, a branch of the common hepatic artery from the coeliac trunk.

Notes

The liver is the largest visceral organ in the body and is primarily located in the right hypochondrium and epigastric region, extending into the left hypochondrium.

Surface marking

Most of the liver is under the right dome of the diaphragm and deep to the lower thoracic wall. The inferior margin of the liver can be palpated descending below the right costal margin on deep inspiration.

The inferior margin is indicated by a line that joins points at the right tenth costal cartilage in the midaxillary line, the tip of the right ninth costal cartilage, the transpyloric plane in the midline, the tip of the left eighth costal cartilage and the left fifth rib in the midclavicular line.

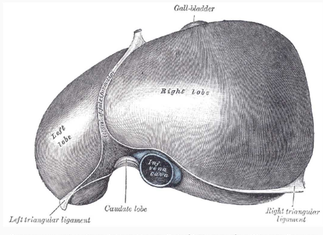
The superior margin is indicated by a line that joints a point on the left fifth rib at the midclavicular line to a corresponding point on the right side. The superior margin is concave in its central part and crosses behind the xiphisternal joint.

Anatomical surfaces

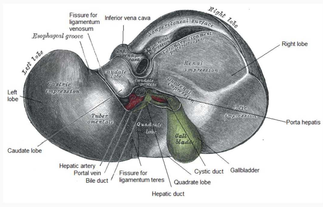
The liver has a diaphragmatic surface in the anterior, superior, and posterior directions and a visceral surface in the inferior direction.

The diaphragmatic surface of the liver is related anteriorly to the anterior abdominal wall and rib cage and superiorly to the diaphragm.

The visceral surface of the liver is related to the oesophagus, right anterior part of the stomach, superior part of the duodenum, lesser omentum, gallbladder, right colic flexure, right transverse colon, right kidney and right adrenal gland.



Diaphragmatic surface of liver. By Henry Vandyke Carter [Public domain], via Wikimedia Commons



Inferior surface of liver. Modified by FRCEM Success. Original by Henry Vandyke Carter [Public domain], via Wikimedia Commons

Lobes

There are four anatomical lobes to the liver.

- The liver is divided into the left and right lobe by the fossae for the gallbladder and the inferior vena cava.
- The caudate lobe sits between the fissure for the ligamentum venosum and the inferior vena cava.
- The quadrate lobe is located between the gallbladder and the fissure for the ligamentum teres.

The porta hepatis is the central intraperitoneal fissure of the liver that separates the caudate and the quadrate lobes. The porta hepatis serves as the point of entry into the liver for the hepatic arteries and portal vein, and the exit point for the hepatic ducts.

Liver lobules

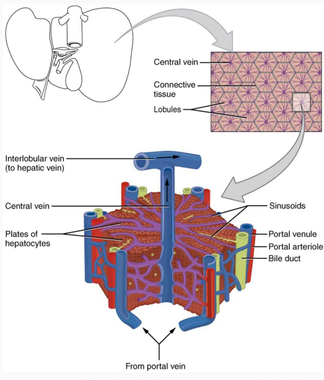
Microscopically, hepatocytes are arranged into lobules which are the functional units of the liver. Each lobule is hexagonal-shaped, and is drained by a venule in its centre, called a central vein (which drains to the hepatic vein).

At the periphery of the hexagon are three structures collectively known as the portal triad, comprising:

- a portal arteriole (a branch of the hepatic artery),
- a portal venule (a branch of the hepatic portal vein),
- a bile duct.

The portal triad also contains lymphatic vessels and vagal parasympathetic nerve fibres.

The liver sinusoids serve as a location for mixing of the oxygen-rich blood from the hepatic artery and the nutrient-rich blood from the portal vein.



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Blood supply

The liver has a unique dual blood supply. The arterial supply to the liver is from the left and right hepatic arteries derived from the hepatic artery proper, a branch of the common hepatic artery from the coeliac trunk.

The hepatic portal vein (formed from the union of the superior mesenteric and splenic vein posterior to the neck of the pancreas at the level of vertebra L2) supplies the liver with deoxygenated blood carrying nutrients absorbed from the small intestine.

Venous drainage of the liver is achieved through three hepatic veins, which return the venous blood to the inferior vena cava just inferior to the diaphragm.

Lymphatic drainage

The lymphatic vessels of the liver drain into hepatic lymph nodes which empty in the coeliac lymph nodes.

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Anatomy: Abdomen



Question 121 of 125

Which of the following is the most common position of the vermiform appendix:

a Pre-ileal

b Post-ileal

c Subcaecal

d Retrocaecal

e Pelvic

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Anatomy: Abdomen

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Which of the following is the most common position of the vermiform appendix:

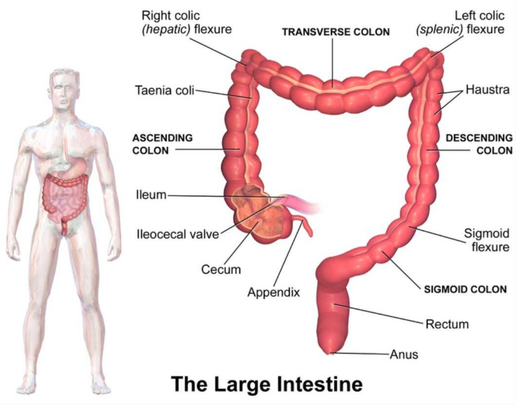
a) Pre-ileal ✖
b) Post-ileal
c) Subcaecal
d) Retrocaecal ✔
e) Pelvic

Answer

The most common position is retrocaecal, followed by pelvic.

Notes

The large intestine extends from the distal end of the ileum to the anus, and comprises the caecum, appendix, colon, rectum and anal canal.



Blausen.com staff. "Blausen gallery 2014". Wikiversity Journal of Medicine. DOI:10.15347/wjm/2014.010. ISSN 20018762. (Own work) [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons

Caecum

The intraperitoneal caecum is the first part of the large intestine. It is inferior to the ileocaecal opening and lies in the right iliac fossa. The caecum is continuous with the ascending colon at the entrance of the ileum and is usually in contact with the anterior abdominal wall. It may cross the pelvic brim to lie in the true pelvis.

Appendix

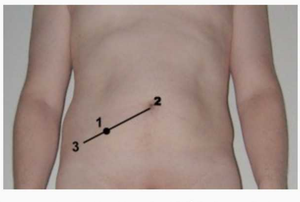
The appendix is attached to the posteromedial wall of the caecum, just inferior to the end of the ileum. The appendix is a narrow, hollow, blind-ended tube. It has large aggregations of lymphoid tissue in its walls and is suspended from the terminal ileum by the mesoappendix.

Its point of attachment to the caecum is consistent with the highly visible free taeniae leading directly to the base of the appendix but the rest of its location is highly variable. It may be:

- 1) posterior to the caecum or the lower ascending colon, or both, in a retrocaecal or retrocolic position
- 2) suspended over the pelvic brim in a pelvic or descending position
- 3) below the caecum in a subcaecal position
- 4) anterior to the terminal ileum, possibly contacting with the body wall in a pre-ileal position or posterior to the terminal ileum in a post-ileal position.

The most common position is retrocaecal, followed by pelvic. The retrocaecal appendix is related anteriorly to the caecum and posteriorly to the psoas major and iliacus muscle. The psoas sign may be positive in retrocaecal appendicitis. Irritation of the psoas muscle (hip flexor) gives rise to pain when the patient's right thigh is extended from a flexed position as the muscle is stretched.

The surface projection of the base of the appendix is at the junction of the lateral and middle one-third of a line from the anterior superior iliac spine to the umbilicus (McBurney's point). People with appendicitis may describe pain at this location.



(1 = McBurney's point, 2 = Umbilicus, 3 = ASIS) By Steven Fruitsmaak [GFDL (http://www.gnu.org/copyleft/fdl.html) or CC-BY-SA-3.0 (http://creativecommons.org/licenses/by-sa/3.0/)], via Wikimedia Commons

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Anatomy: Abdomen



Question 122 of 125

The floor of the inguinal canal is formed primarily by which of the following structures:

a Transversalis fascia

b Medial one-half of the inguinal ligament

c Lateral one-half of the inguinal ligament

d Psoas major muscle

e Pectineus muscle

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Anatomy: Abdomen

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The floor of the inguinal canal is formed primarily by which of the following structures:

a) Transversalis fascia ✗
b) Medial one-half of the inguinal ligament ✓
c) Lateral one-half of the inguinal ligament
d) Psoas major muscle
e) Pectineus muscle

Answer

The floor of the inguinal canal is formed by the medial one-half of the inguinal ligament, reinforced medially by the lacunar ligament.

Notes

Space	Inguinal canal
Position	Between deep and superficial inguinal rings, just above and parallel to lower half of inguinal ligament
Anterior wall	Formed by external oblique aponeurosis (reinforced by internal oblique muscle laterally)
Posterior wall	Formed by transversalis fascia (reinforced by conjoint tendon medially)
Roof	Formed by transversus abdominis and internal oblique muscles
Floor	Formed by medial one-half of inguinal ligament (reinforced by lacunar ligament medially)
Deep inguinal ring	Opening in transversalis fascia, located just superior to mid-inguinal point (midway between ASIS and pubic symphysis)
Superficial inguinal ring	Opening in external oblique aponeurosis, located just superior to pubic tubercle
Contents	Genital branch of genitofemoral nerve, spermatic cord, round ligament, ilioinguinal nerve

Position

The inguinal canal is a slit-like passage that extends in a downwards and medial direction, just above and parallel to the lower half of the inguinal ligament. It begins at the deep inguinal ring and continues for approximately 4 cm, ending at the superficial inguinal ring.

Roof, walls and floor

The anterior wall of the inguinal canal is formed along its entire length by the aponeurosis of the external oblique muscle, and reinforced by the internal oblique muscle laterally.

The posterior wall of the inguinal canal is formed along its entire length by the transversalis fascia and reinforced by the conjoint tendon medially.

The roof of the inguinal canal is formed by arching fibres of the transversus abdominis and internal oblique muscles.

The floor of the inguinal canal is formed by the medial one-half of the inguinal ligament, reinforced medially by the lacunar ligament.

Deep inguinal ring

The deep inguinal ring, the opening in the transversalis fascia, is the beginning of the inguinal canal.

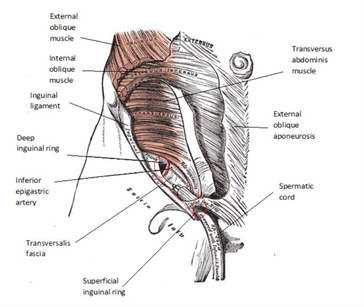
The deep inguinal ring is located just superior to a point midway between the anterior superior iliac spine and the pubic symphysis (the mid-inguinal point). N.B. Some sources state it is located at a slightly different site, just superior to a point midway between the anterior superior iliac spine and the pubic tubercle (the midpoint of the inguinal ligament).

It lies just above the inguinal ligament and immediately lateral to the inferior epigastric vessels; the femoral artery can be palpated in the same position but below the inguinal ligament.

Superficial inguinal ring

The superficial inguinal ring is the end of the inguinal canal.

The superficial inguinal ring is located just superior to the pubic tubercle. It is a triangular opening in the aponeurosis of the external oblique, with its apex pointing superolaterally and its base formed by the pubic crest.



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Contents

The inguinal canal contains:

- the genital branch of the genitofemoral nerve (within the spermatic cord in men)
- the spermatic cord in men
- the round ligament in women
- the ilioinguinal nerve (passes through part of the canal, exiting the superficial inguinal ring with the other contents)

Inguinal hernia

An inguinal hernia is the protrusion of a peritoneal sac through a weakened part of the abdominal wall in the groin.

Hernia	Indirect inguinal hernia	Direct inguinal hernia
Aetiology	Congenital – patent processus vaginalis	Acquired – weakened abdominal musculature
Mechanism	Peritoneal sac herniates through deep inguinal ring	Peritoneal sac herniates directly through posterior wall of inguinal canal
Relation to inferior epigastric vessels	Lateral to inferior epigastric vessels	Medial to inferior epigastric vessels

In indirect inguinal hernias, the most common type, the peritoneal sac enters the inguinal canal by passing through the deep inguinal ring, due to a patent embryonic processus vaginalis. If the entire processus vaginalis remains patent, the peritoneal sac may traverse the length of the canal, exit the superficial inguinal ring and continue into the scrotum or labia majora.

In direct inguinal hernias, the peritoneal sac passes directly through the posterior wall of the inguinal canal. It usually occurs when abdominal musculature has been weakened, in older men, following surgery or due to persistent raised intra-abdominal pressure. This type of hernia does not traverse the inguinal canal, but may still exit the superficial inguinal ring to enter the scrotum.

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Anatomy: Abdomen



Question 123 of 125

The linea alba is formed from which of the following:

a The aponeuroses of the three flat anterior abdominal muscles

b The free edge of the external oblique aponeurosis

c The tendinous intersection of the rectus abdominis muscle

d The thoracolumbar fascia

e The tendon of the pyramidalis muscle

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Anatomy: Abdomen

Question 123 of 125

The linea alba is formed from which of the following:

a) **The aponeuroses of the three flat anterior abdominal muscles** ✔
b) The free edge of the external oblique aponeurosis
c) The tendinous intersection of the rectus abdominis muscle
d) The thoracolumbar fascia
e) The tendon of the pyramidalis muscle

Answer

The linea alba is formed at the midline from the aponeuroses of the external oblique, internal oblique and transversus abdominis muscles, and extends from the xiphoid process to the pubic tubercle.

Notes

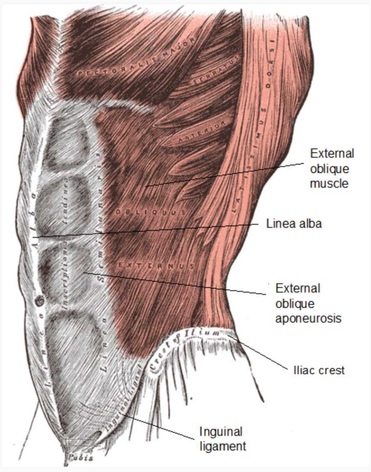
There are five muscles in the anterolateral group of abdominal wall muscles; three flat muscles whose fibres begin posterolaterally and pass anteriorly before being replaced by an aponeurosis as the muscle continues towards the midline (external oblique, internal oblique, transversus abdominis) and two vertical muscles enclosed by the tendinous sheath formed by the aponeuroses of the flat muscles (rectus abdominis, pyramidalis).

External oblique

The external oblique is the largest and most superficial of the anterior abdominal muscles, lying just deep to the superficial fascia. The external oblique originates from the outer surfaces of the lower eight ribs, its fibres running in an inferomedial direction before inserting onto the lateral lip of the iliac crest.

The external oblique has a large aponeurotic component that covers the anterior part of the abdominal wall and forms the linea alba at the midline, together with the aponeuroses from the internal oblique and the transversus abdominis. The linea alba extends from the xiphoid process to the pubic symphysis.

The lower free border of the external oblique aponeurosis forms the inguinal ligament on each side (which runs between the anterior superior iliac spine laterally and the pubic tubercle medially).



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Internal oblique

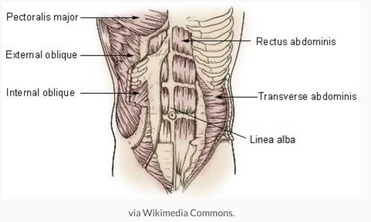
The internal oblique muscle lies deep to the external oblique. Its fibres run in a superomedial direction, originating from the thoracolumbar fascia, the iliac crest and the lateral two-thirds of the inguinal ligament and inserting onto the inferior border of the lower 3 – 4 ribs, the linea alba, the pubic crest and pectineal line.

Transversus abdominis

The transversus abdominis is the innermost of the flat anterior abdominal muscles, lying deep to the internal oblique. It originates from the thoracolumbar fascia, the iliac crest, the lateral one-third of the inguinal ligament and the 7th – 12th costal cartilages and inserts onto the linea alba, the pubic crest and the pectineal line.

Rectus abdominis

The rectus abdominis is a long muscle that extends the length of the anterior abdominal wall. It originates from the pubic crest, pubic tubercle and pubic symphysis and inserts onto the costal cartilages of ribs 5 – 7 and to the xiphoid process. It is a paired muscle, separated in the midline by the linea alba.



via Wikimedia Commons.

Function

The abdominal wall muscles form a firm, but flexible wall that keeps the abdominal viscera within the abdominal cavity, protects the viscera from injury and helps maintain the position of the viscera in the erect posture against the action of gravity.

The muscles act together to flex and rotate the vertebral column.

In addition, contraction of these muscles assists in forced expiration, and in coughing and vomiting, by pushing the viscera upwards. All of these muscles are involved in any action that increases intra-abdominal pressure, including childbirth, micturition and defaecation.

Innervation

The anterior abdominal wall muscles are innervated by the anterior rami of T7 – T12 and L1.

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Anatomy: Abdomen



Question 124 of 125

The arterial supply to the jejunum and ileum is derived predominantly from which of the following:

a Coeliac trunk

b Superior mesenteric artery

c Inferior mesenteric artery

d Renal artery

e Lumbar artery

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Anatomy: Abdomen

Question 124 of 125

The arterial supply to the jejunum and ileum is derived predominantly from which of the following:

a) Coeliac trunk ✗
b) Superior mesenteric artery ✓
c) Inferior mesenteric artery
d) Renal artery
e) Lumbar artery

Answer

The jejunum is mostly in the left upper quadrant of the abdomen.

Notes

The small intestine is the longest part of the gastrointestinal tract and extends from the pyloric orifice of the stomach to the ileocaecal fold, comprising the duodenum, jejunum and ileum.

The jejunum and ileum make up the last two sections of the small intestine.

The jejunum and ileum are intraperitoneal, attached to the posterior abdominal wall by the mesentery.

Jejunum

The jejunum represents the proximal two-fifths. It is mostly in the left upper quadrant of the abdomen and is larger in diameter and has a thicker wall than the ileum.

Ileum

The ileum makes up the distal three-fifths and is mostly in the right lower quadrant. The ileum invaginates into the large intestine at the ileocaecal junction forming the ileocaecal valve, which prevents reflux from the caecum to the ileum and regulates the passage of contents from the ileum to the caecum.

Blood supply

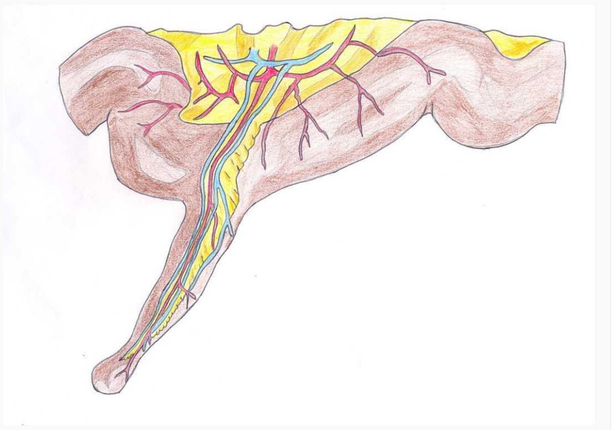
The arterial supply to the jejunum and ileum is derived from the superior mesenteric artery.

Innervation

The sympathetic nerve supply is derived from the T9 – T10 spinal cord segments. Pain from the small jejunum and ileum is referred to the peri-umbilical region.

Meckel's diverticulum

A Meckel's diverticulum is the remnant of the proximal part of the yolk stalk (vitelline duct) that extends into the umbilical cord in the embryo and lies on the antimesenteric border of the ileum, approximately **2 feet** proximal to the ileocaecal junction. It appears as a blind-ended tubular outpouching of bowel, about **2 inches** long, occurring in about **2%** of the population, and may contain **two types** of ectopic tissue (gastric and pancreatic). Complications include haemorrhage, intussusception, diverticulitis, ulceration and obstruction, and symptoms may mimic those of acute appendicitis.



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Anatomy: Abdomen



Question 125 of 125

A 72 year old man presents to ED with severe abdominal pain and diarrhoea. Imaging shows occlusion of the inferior mesenteric artery. Which of the following structures is most likely affected:

a Ascending and descending colon

b Ascending and transverse colon

c Caecum and transverse colon

d Descending and sigmoid colon

e Caecum and ileum

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A 72 year old man presents to ED with severe abdominal pain and diarrhoea. Imaging shows occlusion of the inferior mesenteric artery. Which of the following structures is most likely affected:

a) **Ascending and descending colon** ✘
b) Ascending and transverse colon
c) Caecum and transverse colon
d) Descending and sigmoid colon ✔
e) Caecum and ileum

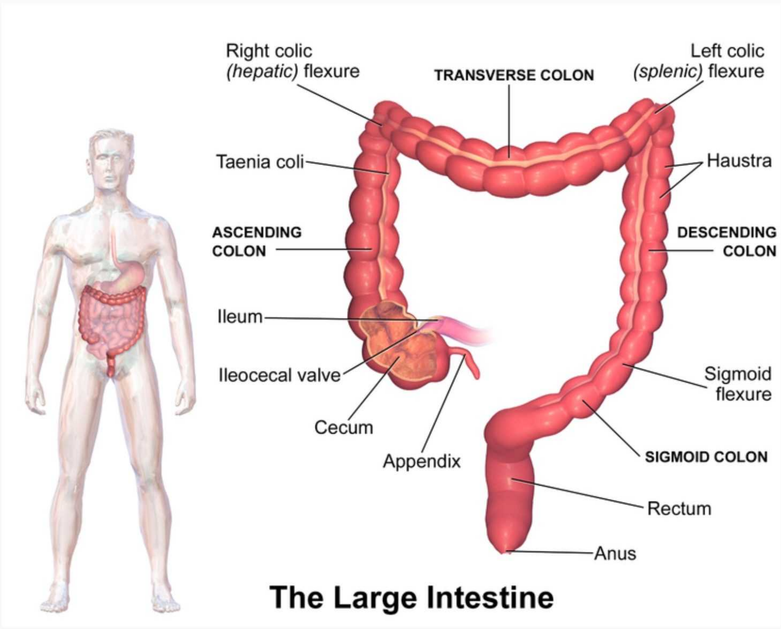
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Answer

The inferior mesenteric artery supplies the hindgut structures including the distal one-third of the transverse colon (and splenic flexure), the descending colon, sigmoid colon and rectum.

Notes

The large intestine extends from the distal end of the ileum to the anus, and comprises the caecum, appendix, colon, rectum and anal canal.



Blausen.com staff. "Blausen gallery 2014". Wikiversity Journal of Medicine. DOI:10.15347/wjm/2014.010. ISSN 20018762. (Own work) [CC BY 3.0 (http://creativecommons.org/licenses/by/3.0)], via Wikimedia Commons

Colon

The colon continues from the caecum in the right groin as the ascending colon, which passes upwards through the right flank and into the right hypochondrium.

Just below the right lobe of the liver, it bends to the left forming the right colic flexure (hepatic flexure), and crosses the abdomen as the transverse colon to the left hypochondrium. The transverse colon is related superiorly to the liver, gallbladder, greater curvature of the stomach and the lateral end of the spleen.

At this point, just below the spleen, it bends downwards forming the left colic flexure (splenic flexure) and continues as the descending colon through the left flank and into the left groin. The splenic flexure is higher and more posterior than the hepatic flexure, and is attached to the diaphragm by the phrenicocolic ligament.

The colon enters the upper part of the pelvis as the sigmoid colon, which begins above the pelvic inlet and extends to the level of vertebra S3 where it is continuous with the rectum. This S-shaped structure is quite mobile except at its proximal and distal end which are attached to the descending colon and rectum respectively. Between these points, it is suspended by the sigmoid mesocolon.

The ascending and descending segments are retroperitoneal and the transverse and sigmoid segments are intraperitoneal.

Relations

Colon	Anterior relations	Posterior relations
Ascending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, right kidney
Transverse colon	Liver, gallbladder, stomach, greater omentum, anterior abdominal wall	Second part of duodenum, head of pancreas, upper end of mesentery, duodenojejunal flexure, coils of jejunum and ileum
Descending colon	Small intestine, greater omentum, anterior abdominal wall	Iliacus and quadratus lumborum, left kidney
Sigmoid colon	Bladder, uterus and upper vagina	Rectum, sacrum, ileum

Blood supply

The arterial supply to the colon is derived from the superior mesenteric artery (caecum, appendix, ascending colon, hepatic flexure, proximal two-thirds of transverse colon) and the inferior mesenteric artery (distal one-thirds of transverse colon, splenic flexure, descending colon, sigmoid colon).

As the terminal vessels of the superior mesenteric and inferior mesenteric artery approach the colon they split into many colic branches which anastomose with each other. These anastomoses from a continuous arterial channel which extends the length of the colon, the marginal artery.

At the junctional area of the supply of the superior and inferior mesenteric arteries, the anastomosis may not be sufficient, thus the splenic flexure is most susceptible to ischaemia.

Innervation

The visceral pain sensation from the ascending and transverse colon travels through the lesser splanchnic nerve to the T10 – T11 spinal cord segments hence pain is referred to the umbilical and hypogastric regions.

Pain from the descending and sigmoid colon is carried in the lumbar splanchnic nerves to the L1 and L2 spinal cord segments hence pain is referred to the inguinal region and thigh.